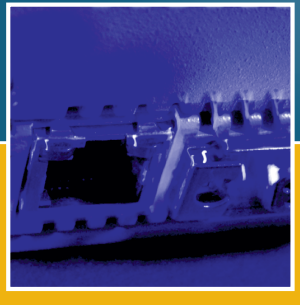
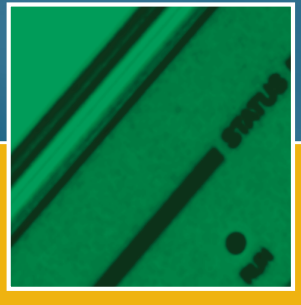
RAPIER SWITCH

USER GUIDE





Allied Telesyn

Allied Telesyn Research Limited

Rapier Switch User Guide
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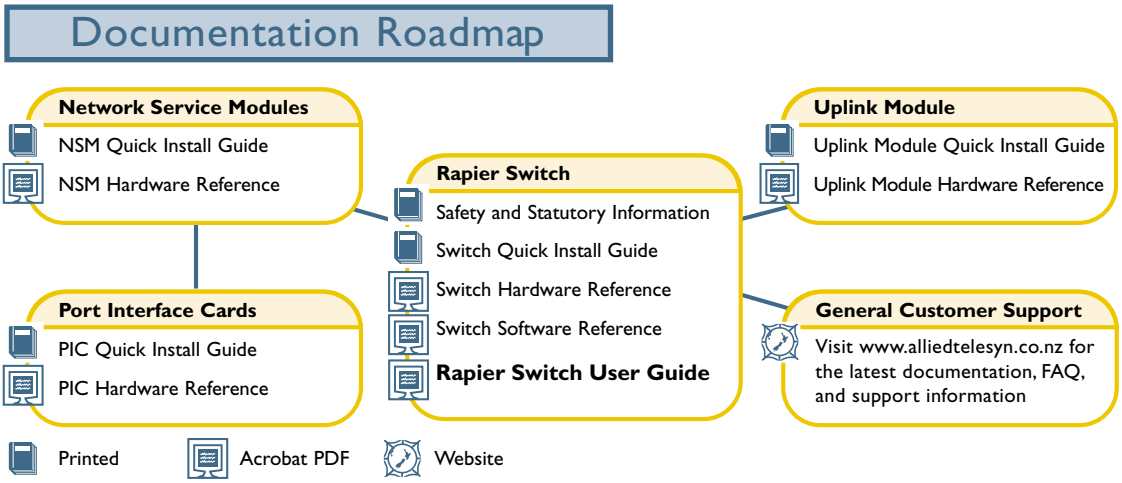
This software product contains an implementation of IPsec certified and tested to meet ICSA Labs IPsec security standards. For more information see http://www.icsa.net.

Contents



Chapter 1

Introduction

Welcome to the Rapier Series Layer 3 Gigabit switch, combining wire speed Layer 2 and Layer 3 IP switching, with a powerful multiprotocol routing software suite.

Why Read This User Guide?

This User Guide describes how to get started accessing the switch's Command Line Interface (CLI) and its Graphical User Interface (GUI), and how to configure the Layer 2 switching features. For more detailed descriptions of all commands and display outputs see the *Rapier Switch Software Reference*. The user guide is organised into the following chapters:

- *Chapter 1, Introduction* introduces the Rapier switch and gives an overview of the features of the Rapier switch and its documentation.
- *Chapter 2, Getting Started* describes how to gain access to the switch's command line and graphical user interfaces.
- *Chapter 3, Operating the Switch* introduces general operation, management and support features, including user authentication, loading and installing support files, and SNMP MIBs.
- *Chapter 4, Layer 2 Switching* describes how to configure Layer 2 switching features, including switch ports, VLANs and STP.
- *Chapter 5, Layer 3 Switching* describes how to use Layer 3 switching over VLANs, including IP, Novell IPX and AppleTalk. Full descriptions of the switch's support for these protocols is found in the *Rapier Switch Software Reference*.

Where To Find More Information

Before installing the switch and any expansion options, read the important safety information in the *Safety and Statutory Information* booklet. Follow the *Quick Install Guides* step-by-step instructions for physically installing the switch and its expansion options. The *Hardware References* give detailed information about the equipment hardware. Once you are familiar with the basic operations of the switch, use the *Software Reference* for full command syntax descriptions and for full descriptions of the switch's routing features.

The latest versions of user documentation for the Rapier family of switches can be downloaded from the on-line support site at *http://www.alliedtelesyn.co.nz/support/rapier*. The documentation set for the Rapier switch includes:

- Rapier Switch Safety and Statutory Information
- Rapier Switch Quick Install Guide
- Rapier Switch Documentation and Tools CD-ROM, which includes the following PDF documents:
  - Rapier Switch Safety and Statutory Information
  - Rapier Switch Quick Install Guide,
  - Rapier Switch Hardware Reference
  - Rapier Switch Software Reference
  - Rapier Uplink Module Quick Install Guide
  - Rapier Uplink Module Hardware Reference
  - Network Service Module Quick Install Guide
  - Network Service Module Hardware Reference
  - Port Interface Card Quick Install Guide
  - Port Interface Card Hardware Reference

Technical support

For on-line support for your Rapier switch, see our on-line support page at *http://www.alliedtelesyn.co.nz/support/rapier*. If you require further assistance, contact your authorised Allied Telesyn distributor or reseller.

This page will also contain the latest release of the switch software. The LOAD command can be used to download software upgrades directly from the Allied Telesyn Research web site to the switch's FLASH memory. Use the SET INSTALL command to enable the new software release ("*Example: Install Software Upgrade for Rapier Switch*" on page 24).

What Can the Rapier Switch Do?

The Rapier switch software support for the Rapier Series switches and their expansion options provides wirespeed Layer 2 switching, including support for Virtual LANs, wirespeed Layer 3 IP switching, and Layer 3 multiprotocol routing.

Switching Features

The main Layer 2 features of the switch are:

- High performance, non-blocking, wire-speed Layer 2 switching ("*Layer 2 Switching Process*" on page 43).
- Packet Forwarding at wire speed ("*The Forwarding Process*" on page 45).
- Store and Forward switching mode.
- Autonegotiation of link speed and duplex mode for 10/100 Mbps speed on all 100BASE TX ports ("*Autonegotiation of Port Speed and Duplex Mode*" on page 29).
- Autonegotiation of duplex mode for 10/100 and gigabit Ethernet ports ("*Autonegotiation of Port Speed and Duplex Mode*" on page 29).
- Automatic, configurable MAC address learning and ageing, supporting up to 8191 MAC addresses per switch ("*The Learning Process*" on page 44).
- Switch Filtering ("*Layer 2 Filtering*" on page 46).
- Layer 3 Filtering (*Switching* chapter in *Rapier Switch Software Reference*).
- Broadcast Storm Protection ("*Packet Storm Protection*" on page 32).
- Virtual LANs defined by port membership ("*Virtual LANs*" on page 35).
- Spanning Tree Protocol ("*Spanning Tree Protocol (STP)*" on page 49).
- Priority tagging to support four QOS egress queues ("*Quality of Service*" on page 48).
- Port trunking to spread traffic over several links ("*Port Trunking*" on page 30).
- Port mirroring ("*Port Mirroring*" on page 33).
- IGMP (Internet Group Management Protocol) snooping ("*IGMP Snooping*" on page 56).

Routing Features

In addition to Layer 2 and Layer 3 switching, the Rapier switch provides a wide array of multiprotocol routing, security and network management features.

IP routing is performed at wire-speed. Other Layer 3 routing is performed by the CPU, and increasing the routing load on the CPU decrease its performance.

Some features require the addition of WAN interfaces via Network Service Modules (NSMs) and Port Interface Cards (PICs) installed in the NSM bay on the rear of the switch.

Features provided by the routing software suite include:

- IP version 4 routing.
- Network Address Translation (NAT) (not between switch ports)
- Dynamic IP Address Assignment
- IP Dynamic Filtering Firewall
- IP Multihoming
- IP RIP and IP RIPv2
- DNS Relay
- Demand IP
- IP Filtering (not between switch ports)
- IP Packet Prioritisation (not between switch ports)
- Generic Routing Encapsulation (GRE)
- Basic Rate and Primary Rate access to Integrated Services Digital Network (ISDN) services, with dial-on-demand and channel aggregation.
- Time Division Multiplexing (TDM) over G.703 links
- Frame Relay
- X.25
- ARP, Proxy ARP and Inverse ARP address resolution protocols.
- BACP (Bandwidth Allocation Control Protocol)
- PPP Multilink
- PPP over Ethernet (PPPoE)
- Bandwidth on Demand
- CLI, PAP and CHAP
- Virtual Router Redundancy Protocol (VRRP) for fault tolerant internet gateways (on NSM ports only)
- IPsec
- ISAKMP Key Management
- Data Compression
- Predictor Data Compression
- STAC Data Compression
- L2TP

- Telnet client and server.
- A sophisticated and configurable event logging facility for monitoring and alarm notification to single or multiple management centres.
- Triggers for automatic and timed execution of commands in response to events.
- Scripting for automated configuration and centralised management of configurations.
- Dynamic Host Configuration Protocol (DHCP) for automatically assigning IP addresses and other configuration information to PCs and other hosts on TCP/IP networks.
- Group management support for IP multicasting: IGMP version 2.
- Support for the Simple Network Management Protocol (SNMP), standard MIBs and the Allied Telesyn Enterprise MIB, enabling the switch to be managed by a separate SNMP management station.
- An HTTP client that allows files to be downloaded directly from a web server to the switch's FLASH memory, and an HTTP server that serves web pages from FLASH.

For a complete description of the switch's routing software, see the *Rapier Switch Software Reference*. Note that the Software Reference uses the word "router" for the switch when it describes routing features.

Advanced Feature Licence AT-RPFL3Upgrade

If you purchased the advanced feature licence AT-RPFL3Upgrade, you can also use the following features on your switch:

- IP Multicast routing: DVMRP and PIM-Sparse Mode
- IPX routing
- Demand IPX
- IPX/SPX Spoofing
- IPX Filtering (not between switch ports)
- AppleTalk routing
- Resource Reservation Protocol (RSVP).

See "*Enable AT-RPFL3Upgrade Feature Licence*" on page 13.

Optional Features

Some additional features in the switch software may require special feature licences and passwords.

- SecureShell Remote Management
- Nemesis stateful inspection firewall
- Firewall SMTP Application Gateway
- Triple DES encryption
- Support for Public Key Infrastructure.

Passwords must be ordered from your local distributor or reseller. You must specify the special features to be licenced and the serial number(s) of the switch(s) on which the special feature licences are to be enabled.

Chapter 2

Getting Started

The Rapier switch is supplied with default settings which allow it to operate immediately as a switch, without any configuration. Even if this is all you want to use the switch for, you should still gain access to the switch configuration, if only to change the *manager* password to prevent unauthorised access.

To take advantage of the full range of advanced Layer 2 switching features, the switch configuration must be changed. Layer 3 routing capabilities may also require detailed configuration. The switch has both a Command Line Interface (CLI) and a Graphical User Interface (GUI) for configuration and management. Before you can use the GUI, you will need to login to the switch and use its CLI to allocate an IP address.

Simple Switching

If all you want the switch to do is switch traffic on your LAN, you need not perform any configuration. Simply power up the switch and connect devices to the switch ports. Switch learning is enabled by default, and all valid packets will be forwarded ("*Layer 2 Switching Process*" on page 43).

Command Line Interface

To use the command line interface (CLI) for configuring the switch, the first thing you need to do after physically installing the switch is to start a terminal session to access the switch (see Table 1 and the *Rapier Switch Quick Install Guide*).

To start a terminal session, do one of the following:

- Connect a VT100-compatible terminal to the RS-232 Terminal Port, set the communications parameters on the terminal (Table 1 on page 12), and press [Enter] a few times until the switch's login prompt appears; *or*
- Connect the COM port of a PC running terminal emulation software such as Windows Terminal or HyperTerminal to the RS-232 Terminal Port, set the communications parameters on the terminal emulation software (Table 1 on page 12), and press [Enter] a few times until the switch's login prompt appears.

Table 1: Parameters for terminal communication

Parameter	Value
Baud rate	9600
Data bits	8
Parity	None
Stop bits	1
Flow control	Hardware

Logging In

A user accessing the switch from a terminal or PC connected to the front panel RS-232 terminal port (asyn0), or via a Telnet connection, must enter a login name and password to gain access to the command prompt. When the switch is supplied, it has a *manager* account with an initial password *friend*. Enter your login name at the login prompt:

Enter your login name at the login prompt:

```
login: manager
```

Enter the password at the password prompt:

```
password: friend
```

This password should be changed to prevent unauthorised access to the switch, using the command:

```
SET PASSWORD
```

Make sure you remember the new password you create, as a lost password cannot be retrieved, and would mean losing access for configuring and monitoring the switch.

Giving the Switch an IP Address

Once you have logged into the *manager* account you will be able to enter commands from this document and from the *Rapier Switch Software Reference*.

Add an IP interface over the default VLAN (vlan1) and assign it an IP address (e.g. 192.168.1.1), using the command:

```
ADD IP INTERFACE=vlan1 IPADDRESS=192.168.1.1
```

Once the switch is configured with an IP address, the command line interface can also be accessed by using Telnet to the switch from an IP host.

Entering Commands

The switch is controlled with commands described in this document and in the *Rapier Switch Software Reference*. While the keywords in commands are not case sensitive, the values entered for some parameters are. The switch supports command line editing and recall (Table 2 on page 13).

Table 2: Command line editing functions and keystrokes

Function	VT100-compatible Keystroke
Move cursor within command line	←, →
Delete character to left of cursor	[Delete] or [Backspace]
Toggle between insert/overstrike	[Ctrl/O]
Clear command line	[Ctrl/U]
Recall previous command	↑ or [Ctrl/B]
Recall next command	↓ or [Ctrl/F]
Display command history	[Ctrl/C] or SHOW ASYN HISTORY
Clear command history	RESET ASYN HISTORY
Recall matching command	[Tab] or [Ctrl/I]

Enabling the GUI

To enable the GUI, an IP address must be assigned to a switch interface, and the GUI must be enabled, using the CLI. Use the command:

```
ENABLE GUI
```

Manager account privileges are required to enable the switch GUI, but manager privileges are not required to use the GUI once it is enabled. Therefore, managers should ensure the physical security of the switch.

Enable AT-RPFL3Upgrade Feature Licence

If you have purchased an advanced feature upgrade licence it must be enabled before you can use the advanced routing features. You will need the password provided by your authorised Allied Telesyn distributor or reseller. The advanced upgrade licence and password are different from the standard software release licence and password. The licence cannot be transferred from one switch to another.

The password for a special feature licence is a string of at least 16 hexadecimal characters, and encodes the special feature or features covered by the license, and the switch serial number. The password information is stored in the switch's FLASH memory.

To enable or disable the AT-RPFL3Upgrade use the commands:

```
ENABLE FEATURE=AT-RPFL3Upgrade PASSWORD=password

DISABLE FEATURE=AT-RPFL3Upgrade
```

Other features on the switch, such as Firewall, Remote Secure Shell and Triple DES encryption, and support for Public Key Infrastructure may also need special feature licences. To list the current special feature licences use the command:

```
SHOW FEATURE[={featurename|index}]
```

Passwords must be ordered from your local distributor or reseller. You must specify the special features to be licenced and the serial number(s) of the switch(s) on which the special feature licences are to be enabled.

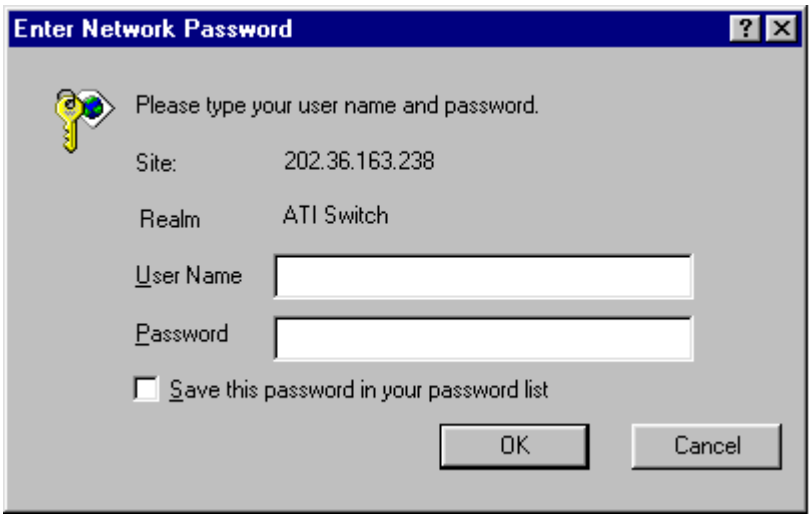
Graphical User Interface

The switch includes a built-in web browser based GUI for configuring and monitoring the switch. Before you can access the GUI, it must be enabled using the CLI ("*Command Line Interface*" on page 11). You need a web browser to access the GUI. If you do not have one installed on your PC, install Netscape Communicator or Microsoft Internet Explorer from the *Rapier Switch Documentation & Tools CD-ROM*. Some features may still need to be configured using the CLI. GUI pages may differ slightly from those shown below, depending on the web browser and software version you are using.

Starting the GUI

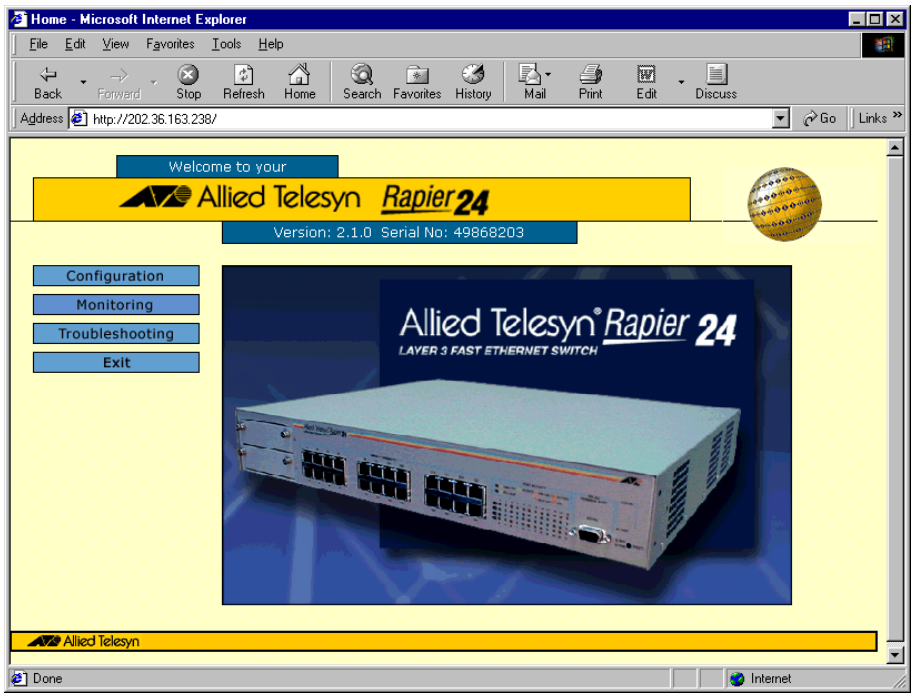
Point your web browser at the IP address you have assigned to the switch, for example, http://192.168.1.1. The authentication window appears (Figure 1). The "*Enter Network Password dialog*" allows only authorised users with the correct password to access the switch. (The appearance of this dialog may differ depending on the browser you use.)

Figure 1: Enter Network Password dialog



- Enter the username *manager* and the password *friend*. The GUI Main Screen opens (Figure 2).

Figure 2: Rapier 24 Welcome page



- Save this page as a bookmark in your web browser, so that you can easily find it again.

Navigating

While using the Rapier GUI, use the buttons on the pages to navigate, not the browser's Back and Forward buttons, to ensure that configuration information is stored correctly.

The GUI is made up of Configuration pages, Monitoring pages and a Troubleshooting page. Click on a menu item on the left to select the Configuration, Monitoring or Troubleshooting pages.

Using help mode

Clicking Help opens help mode pages which show any help text available for the current configuration page. Navigate through help mode pages in the same way as navigating through the configuration pages. To return to the configuration page corresponding to your current help mode page, click Exit Help.

Configuring

Once in the Configuration page, select the type of configuration you want to change. Tabs on the resulting pages allow you to modify a range of features. Ports affected by the configuration are selected by clicking on a port in the port map. To apply configuration changes selected or entered on a page, click Apply. This saves the configuration in the switch's memory, so that it affects its current functioning, and updates the configuration file in FLASH memory ("*Configuration Scripts*" on page 19).

To restore default settings on a configuration page, click Defaults to show the defaults, then click Apply to apply the default settings shown.

Monitoring

In the Monitoring page, select the kind of monitoring you want to display. A pop-up display page locks the base page from which it was opened. Click OK to close the pop-up window and return to its base window.

Troubleshooting

Web pages can sometimes become frozen if they are not navigated correctly. They can be unlocked by restarting the web browser.

In the Troubleshooting page you can enter any command from the *Rapier Switch Software Reference*. The command is executed on the switch, and any output is displayed in the Troubleshooting page.

Exiting

To leave the Rapier GUI, click the Exit button on any page. You will need to log in again next time you access the switch GUI.

Changing your password

If you have not yet changed the initial *manager* password, you should do this now. To change the password, click System. In the System configuration page, enter a new password in the password field for the *manager* account. Click Apply to save this change. This is the password you will use the next time you log in to the switch as *manager*. Make sure you remember the new password, as there is no way to retrieve it if it is lost.

Chapter 3

Operating the Switch

This chapter introduces general operation, management and support features, including user authentication, loading and installing support files, and SNMP MIBs. For more information see *Chapter 1, Operation* in the *Rapier Switch Software Reference*.

User Privileges

The command processor supports three levels of privilege, USER, MANAGER, and SECURITY OFFICER, distinguished by the prompt displayed by the command processor when it is ready to receive commands. A USER level prompt looks like:

```
>
```

while a MANAGER prompt looks like:

```
Manager >
```

and a SECURITY OFFICER prompt looks like:

```
SecOff >
```

See *Chapter 1, Operation* in the *Rapier Switch Software Reference* for more information about creating new accounts with user, manager and security officer privileges.

File Subsystem

FLASH memory is structured like a file subsystem. Files can be saved, renamed, listed and deleted. Release files, online help files, configuration scripts and other scripts are all stored as files in FLASH memory. Names must have DOS format, with a filename of up to eight characters and an extension of three characters.

To display the files in FLASH, use the command:

```
SHOW FILE
```

Figure 3: Example output from the SHOW FILE command.

```
Filename           Device        Size     Created                 Locks
-------------------------------------------------------------------------
1mac.scp           flash         527      08-Nov-2000 12:46:00    0
86s-210.rez        flash         1690736  14-Sep-2000 14:11:56    0
config.scp         flash         64       10-Nov-2000 23:26:31    0
hdroute.scp        flash         374      08-Nov-2000 12:46:00    0
loadup.scp         flash         173      20-Nov-2000 07:03:30    0
loadup1.scp        flash         224      14-Nov-2000 14:11:56    0
quick.scp          flash         2036     08-Nov-2000 12:46:00    0
release.lic        flash         32       08-Nov-2000 12:46:00    0
sleep.scp          flash         189      08-Nov-2000 12:46:00    0
test.cfg           flash         1698     09-Nov-2000 10:39:42    0
-------------------------------------------------------------------------
```

The Locks field indicates the number of concurrent processes using the file.

The switch automatically compacts FLASH memory when a maximum threshold of deleted files is reached. Compaction frees space for new files by discarding garbage. A message will appear when FLASH compaction has been activated. Another message appears when FLASH compaction is complete.

While FLASH is compacting, do not restart the switch or use any commands that affect the FLASH file subsystem. Do not restart the switch, or create, edit, load, rename or delete any files until a message confirms that FLASH file compaction is completed. Interrupting flash compaction may result in damage to files.

Online CLI Help

Online help is available for all switch commands in the CLI. Typing a question mark "?" at the end of a partially completed command displays a list of the parameters that may follow the current command line, with the minimum abbreviations in uppercase letters. The current command line is then re-displayed, ready for further input.

An online help facility provides more detailed help information via the command:

```
HELP [topic]
```

If a topic is not specified, a list of available topics is displayed. The HELP command displays information from the system help file stored in FLASH memory. The help file used by the HELP command must be defined using the command:

```
SET HELP=helpfile
```

The current help file and other system information can be displayed with the command:

```
SHOW SYSTEM
```

Figure 4: Example of output from the SHOW SYSTEM command

```
Switch System Status                              Time 14:29:17 Date 12-Sep-2000.
Board      ID  Bay Board Name                        Rev   Serial number
-------------------------------------------------------------------------------
Base       86      AT-RP24 Rapier 24                P2-1  49867449
-------------------------------------------------------------------------------
Memory -   DRAM : 32768 kB    FLASH :  6144 kB
-------------------------------------------------------------------------------
SysDescription
CentreCOM AT-RP24 Rapier 24 version 2.1.0-00 04-Sep-2000
SysContact

SysLocation

SysName

SysUpTime
30262 ( 00:05:02 )
Software Version: 2.1.0-00 04-Sep-2000
Release Version : 2.1.0-00 04-Sep-2000
Release built   : Sep 12 2000 at 14:28:59
Patch Installed : NONE
Territory       : usa
Help File       : help.hlp

Main PSU        : On          Main Fan        : On
RPS Monitor     : On          RPS Connected   : Yes
RPS  PSU        : On

Boot configuration file: vts.cfg (exists)
Current configuration: vts.cfg
Security Mode   : Disabled

Warning (248283): No patches found.
```

Configuration Scripts

At boot the switch executes the commands in the boot script to configure the switch. A boot script is a sequence of standard commands that the switch executes at start-up. The default boot script is called `boot.cfg`, but an alternative script file can be defined as the boot script using the command:

```
SET CONFIG=filename
```

A configuration file is a script made up of the same commands as are used in the CLI. It can be edited manually using the switch's built in editor ("*Editor*" on page 20), or uploaded to a PC and edited using any text editor using the UPLOAD command (*Chapter 1, Operation* in the R*apier Switch Software Reference*.

Saving Configuration Entered with the GUI

Configuration changes applied using the GUI automatically update the configuration script specified in the SET CONFIG command.

Saving Configuration Entered with the CLI

Subsequent commands entered from the command line or executed from a script affect only the dynamic configuration in memory, which is not retained over a power cycle. Changes are not automatically stored in nonvolatile memory. When the switch is restarted the configuration will be restored to that defined by the boot script, or if the switch was restarted using the RESTART command, any script specified in the RESTART command.

To retain any configuration changes made after boot across a restart or power cycle, save the modified configuration as a script file, using the command:

```
CREATE CONFIG=filename
```

The configuration file created by the GUI or the CREATE CONFIG command records passwords in encrypted form, not in cleartext.

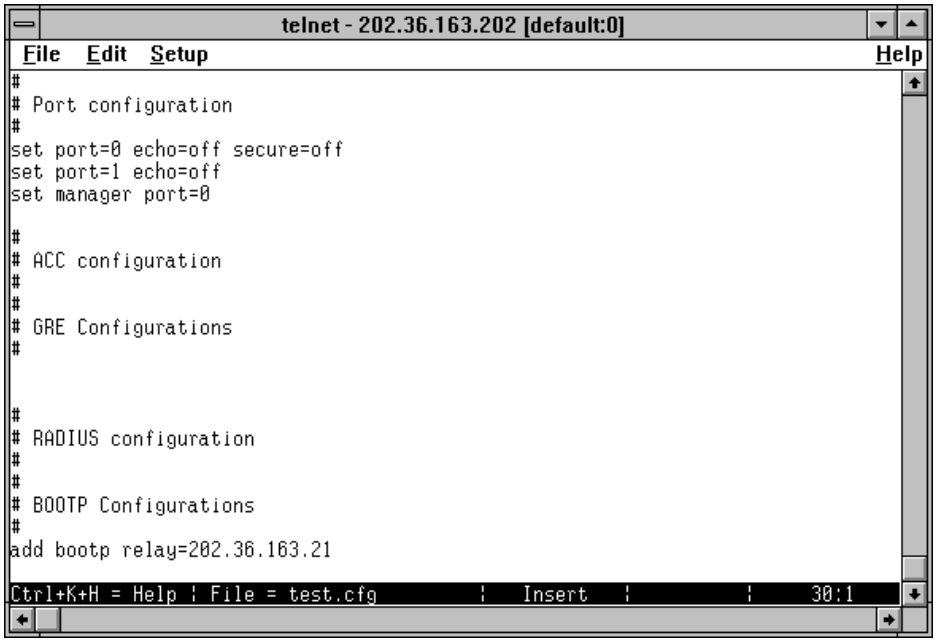
Editor

The switch has a built-in full-screen text editor for editing script files stored on the switch file subsystem. Scripts can be run manually, or run when a trigger automatically activates on some specified events in the switch. See "Triggers" on page 58, and the *Trigger Facility* chapter in the *Rapier Switch Software Reference*. To access the editor, use the command:

```
EDIT [filename]
```

The file name is optional as a file can be loaded, or a new file can be created from within the editor itself (Figure 5 on page 20).

Figure 5: The editor screen layout.



The editor uses VT100 command sequences and should only be used with a VT100-compatible terminal, terminal emulation program or Telnet client.

To display editor Help at any time while in the editor press [Ctrl/K,H]; that is, hold down the Ctrl key and press in turn the K key then the H key.

Install Information

The INSTALL module is responsible for maintaining install information and loading the correct install at boot. A release is a binary file containing the code executed by the switches CPU. There may also be a patch file, and additional binary file that modifies the original release file. An *install* is a record identifying a release and an optional patch. Three installs are maintained by the INSTALL module, *temporary, preferred* and *default*.

The default install is the install of last resort. The release for the default install can not be changed by the manager and is always the EPROM release. The patch for the default install may be set by the manager.

The temporary and preferred installs are completely configurable. Both the release and an associated patch may be set. The release may be EPROM or a release stored in FLASH.

The three different installs are required to handle the following situations:

- A default install is required to handle the case when only the EPROM release is present.
- A temporary install is required to allow a release and/or patch to be loaded once only, in case it causes a switch crash.
- A preferred install is required because the default install can not be anything other than the EPROM.

The install information is inspected in a strict order. The temporary install is inspected first. If this install information is present, the temporary install is loaded. At the same time, the temporary install information is deleted. This ensures that if the switch reboots immediately as the result of a fatal condition caused by the temporary install, the temporary install will not be loaded a second time.

If there is no temporary install defined, or the install information is invalid, the preferred install is inspected. If present, this install is loaded. The preferred install information is never deleted.

If neither temporary nor preferred installs are present, the default install is used. The default install will always be present in the switch, because if, for some reason, it is not, the INSTALL module will restore it.

The preferred install should not be set up with an untested release or patch. It is advisable to install new releases or patches as the temporary install, and when the switch boots correctly, to then set up the preferred install with the new release or patch.

To change the install information in the switch, use the command:

```
SET INSTALL={TEMPORARY|PREFERRED|DEFAULT}
    [RELEASE={release-name|EPROM}] [PATCH[=patch-name]]
```

The INSTALL parameter specifies which install is to be set. The INSTALL module is responsible for maintaining install information and loading the correct install at boot. An *install* is a record identifying a release and an optional patch. Three installs are maintained by the INSTALL module, *temporary, preferred* and *default*.

The default install is the install of last resort. The release for the default install can not be changed by the manager and is always the EPROM release. The patch for the default install may be set by the manager.

The temporary and preferred installs are completely configurable. Both the release and an associated patch may be set. The release may be EPROM or a release stored in FFS.

The RELEASE parameter specifies the release file for this install. The release file is either a file name of the form `device:filename.ext` for files in the file subsystem, or EPROM, to indicate the EPROM release. The default value for the device field is FLASH.

The PATCH parameter specifies the patch file for this install, and is a file name of the form `device:filename.ext`. The patch file is stored in FLASH. The default value for the device field is `FLASH`. If the patch name is not given, the patch file information for a given install is removed and only the release file will be loaded for the install.

A patch file can not be set up for an install unless a release file is already set up, or a release file is specified in the same command. This stops the inadvertent setting of an install to be just a patch file. When the switch reboots in such a case the particular install is ignored, which may have undesirable effects on the switch operation.

For security reasons this command will only be accepted if the user has SECURITY OFFICER privilege.

To delete a particular install (except the default install) use the command:

```
DELETE INSTALL
```

To display the current install information, including which install is currently running in the switch, and how the install information was checked at the last reboot, use the command:

```
SHOW INSTALL
```

Figure 6: Example output from the SHOW INSTALL command.

```
Install     Release              Patch                Dmp
-------------------------------------------------------------------------
Temporary   -                    -                    -
Preferred   flash:86s-210.rez    -                    -
Default     EPROM (8-1.6.0)      -                    -
-------------------------------------------------------------------------

Current install
-------------------------------------------------------------------------
Preferred   flash:8d-181.rez     -                    -
-------------------------------------------------------------------------

Install history
-------------------------------------------------------------------------
No Temporary install selected
Preferred install selected
Preferred release successfully installed
Preferred patch successfully installed
-------------------------------------------------------------------------
```

Releases and Patches into the Switch

The LOADER module is responsible for loading and storing releases, patches and other files into FLASH. The LOADER module uses the *Trivial File Transfer Protocol* (TFTP), *Hypertext Transfer Protocol* (HTTP) or ZMODEM over an asynchronous port, to retrieve files from a network host. The FFS module is used to create, write and destroy release and patch files.

The loader can be configured with the command:

```
SET LOADER [DELAY=delay|DEFAULT]
    [DESTINATION={FLASH|DEFAULT}] [FILE=filename]
    [HTTPPROXY={hostname|ipadd|DEFAULT}]
    [METHOD={HTTP|TFTP|WEB|WWW|ZMODEM|NONE|DEFAULT}]
    [ASYN=port|DEFAULT] [PROXYPORT=1..65535|DEFAULT]
    [SERVER={hostname|ipadd|DEFAULT}]
```

This command sets default values for the name of the file to load, the network host to load it from, and the memory location in which to store the file. These default values can be overridden when the load actually takes place. A time delay between initiating a load and the start of the load can also be configured.

The DELAY parameter specifies the delay, in seconds, between initiating the file download and the download actually starting. This feature is provided to allow reconfiguration of ports and devices after initiating the download. For example, a manager may be at a remote site with a single PC which is to act as both the access device to the switch and the TFTP server. By specifying a delay, the manager has time to reconfigure the PC from terminal emulation mode to TFTP server mode before the download starts. The DELAY parameter is optional. If DEFAULT is specified, this parameter is set to the factory default, which is no delay.

The DESTINATION parameter specifies where the file will be stored. If FLASH is specified, the file is stored in the FLASH File System (FFS) on the switch. If DEFAULT is specified, this parameter is set to the factory default, FLASH.

The FILE parameter specifies the name of the file, in the syntax of the server from which the file will be downloaded. The FILE parameter is a full path name rather than just a file name. The only restriction is that the last part of the parameter must be a valid file name for the LOADER module. When METHOD is set to TFTP, HTTP, ZMODEM or NONE, valid file names are of the form `filename.ext` where `filename` is one to eight characters in length and `ext` is three characters in length. The following are examples of valid file names for methods TFTP, ZMODEM or NONE:

```
\user\public\filename.ext ; UNIX or DOS server
[network.cfg]filename.ext ; DEC VAX server
```

Note that, starting at the end of the file name and working backwards, the first character not valid in file names delimits a valid file name for the switch. If the slash at the beginning of the path is omitted in this command, the LOAD command adds it. The following are examples of valid file names for method HTTP:

```
/path/filename.ext
```

```
path/filename.ext
```

The HTTPPROXY parameter specifies the proxy server used to handle HTTP requests. Either the IP address or the fully qualified domain name of the proxy server may be specified. If a domain name is specified, the switch will perform a DNS lookup to resolve the name. If DEFAULT is specified, this parameter is

set to the factory default, which has no value set for HTTPPROXY, clearing any value previously set as default.

The METHOD parameter specifies the method to use when downloading the file. If HTTP is specified, HTTP is used to download the file. The options WEB and WWW are synonyms for HTTP. If TFTP is specified, TFTP is used to download the file. If ZMODEM is specified, the ZMODEM protocol is used to download the file. If ZMODEM is specified, the PORT parameter must be specified, unless it has been set with the SET LOADER command. If NONE is specified, only text files can be downloaded and all input received via the port will be directed to the specified file on the switch's file subsystem. The file transfer is terminated by the first control character received that is not a CR or LF character. The FILE parameter is not valid when METHOD is set to ZMODEM. The PORT parameter is not valid when METHOD is set to HTTP, WEB, WWW, TFTP or NONE. If DEFAULT is specified, this parameter is set to the factory default, which is TFTP.

The ASYN parameter specifies the asynchronous port via which the file will be downloaded, when the METHOD parameter is set to ZMODEM or NONE. If METHOD is set to ZMODEM or NONE, the PORT parameter is required unless it has been set with the SET LOADER command. If DEFAULT is specified, this parameter is set to the factory default, which is no PORT set, clearing any value previously set as default.

The PROXYPORT parameter specifies the port on a proxy server. The PROXYPORT parameter is only valid if METHOD is HTTP and HTTPPROXY is specified. If DEFAULT is specified, this parameter is set to the factory default, which is 80.

The SERVER parameter specifies the IP address or the host name (a fully qualified domain name) of the TFTP server or HTTP server from which the file is loaded. If a host name is specified, a DNS lookup is used to translate this to an IP address. The SET IP NAMESERVER command can be used to define name servers. The PING command can be used to verify that the switch can communicate with the server via IP. The SERVER parameter is not used when METHOD is set to ZMODEM or NONE. The following are examples of valid server names when METHOD is set to HTTP:

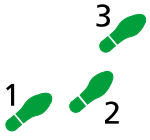
```
host.company.com
```

```
192.168.3.4
```

If DEFAULT is specified, this parameter is set to the factory default, which has no value set for SERVER, clearing any value previously set as default.

Example: Install Software Upgrade for Rapier Switch

This example downloads a compressed release from the Rapier Support site to the switch's FLASH memory using HTTP.



To install a compressed release:

1. **Download the release files to the switch.**

   The release file is downloaded to the switch with the command:

   ```
   LOAD METHOD=HTTP DESTINATION=FLASH
       FILE=/support/rapier/downloads/86s-210.rez
       SERVER=www.alliedtelesyn.co.nz HTTPPROXY=proxy-address
       PROXYPORT=proxy-port
   ```

where *proxy-address* is the fully qualified domain name (e.g. proxy.mycompany.com) or IP address (e.g. 192.168.1.1) of the proxy server, and *proxy-port* is the port number of the proxy port on the proxy server. If access from the switch to the world wide web is not via a proxy server, the HTTPPROXY and PROXYPORT parameters should be omitted.

The process of downloading a release file can take some time, even if the switch and the HTTP server are connected by high speed links. An indicative time for downloading a release over Ethernet is 5 to 10 minutes. The progress of the download can be monitored with the command:

```
SHOW LOAD
```

When the download has completed, the presence of the files in FLASH can be displayed with the command:

```
SHOW FILE
```

This shows the file 86s-210.rez is present.

2. Test the release.

The release can now be tested, using the command:

```
SET INSTALL=TEMPORARY RELEASE=86s-210.REZ
```

The install information can be checked with the command:

```
SHOW INSTALL
```

The switch is then rebooted, and the install is checked again. This display should indicate, in the install history, that the temporary install was loaded.

3. Make the release the default (permanent) release.

If the switch operates correctly with the new release, the release may be made permanent with the command:

```
SET INSTALL=PREFERRED RELEASE=86s-210.REZ
```

Every time the switch reboots from now on, the new release will be loaded from FLASH.

Other load methods are described in the *Operations* chapter in the *Rapier Switch Software Reference*.

SNMP and MIBs

The switch's implementation of SNMP is based on RFC 1157 "*A Simple Network Management Protocol (SNMP)*", and RFC 1812, "*Requirements for IP Version 4 Routers*". The SNMP agent is disabled by default. To enable SNMP, use the command:

```
ENABLE SNMP
```

SNMP *communities* are the main configuration item in the switch's SNMP agent, and are defined in terms of a list of IP addresses which define the SNMP application entities (trap hosts and management stations) in the community. An SNMP community is created using the command:

```
CREATE SNMP COMMUNITY=name [ACCESS={READ|WRITE}]
    [TRAPHOST=ipadd] [MANAGER=ipadd]
    [OPEN={ON|OFF|YES|NO|TRUE|FALSE}]
```

Authentication failure traps and link state traps can be enabled using the commands:

```
ENABLE SNMP AUTHENTICATE_TRAP
```

```
ENABLE INTERFACE=interface LINKTRAP
```

where *interface* is the name of an interface, such as vlan11.

The command:

```
SHOW SNMP
```

displays the current state and configuration of the SNMP agent (Figure 7 on page 26).

Figure 7: Example output from the SHOW SNMP command.

```
SNMP configuration:
  Status ......................... Enabled
  Authentication failure traps .... Enabled
  Community ...................... public
    Access ....................... read-only
    Status ....................... Enabled
    Traps ........................ Enabled
    Open access .................. Yes
  Community ...................... Administration
    Access ....................... read-write
    Status ....................... Disabled
    Traps ........................ Disabled
    Open access .................. No

SNMP counters:
  inPkts ......................... 0       outPkts ......................... 0
  inBadVersions .................. 0       outTooBigs ...................... 0
  inBadCommunityNames ............ 0       outNoSuchNames .................. 0
  inBadCommunityUses ............. 0       outBadValues .................... 0
  inASNParseErrs ................. 0       outGenErrs ...................... 0
  inTooBigs ...................... 0       outGetRequests .................. 0
  inNoSuchNames .................. 0       outGetNexts ..................... 0
  inBadValues .................... 0       outSetRequests .................. 0
  inReadOnlys .................... 0       outGetResponses ................. 0
  inGenErrs ...................... 0       outTraps ........................ 0
  inTotalReqVars ................. 0
  inTotalSetVars ................. 0
  inGetRequests .................. 0
  inGetNexts ..................... 0
  inSetRequests .................. 0
  inGetResponses ................. 0
  inTraps ........................ 0
```

The following MIBs are supported:

- MIB II (RFC 1213)
- Ethernet MIB (RFC 1643)
- Trap MIB (RFC 1215)
- RMON Groups 1, 2, 3, and 9 (RFC 1757)
- AR Router portion of the ATI/ATKK Enterprise MIB
- Portions of the Extended Interface MIB (RFC 1573)

Chapter 4

Layer 2 Switching

This section describes the Layer 2 switching features on the Rapier switch, and how to configure them.

Switch Ports

Each Ethernet switch port is uniquely identified by a port number. The switch supports a number of features at the physical level that allow it to be connected in a variety of physical networks. This physical layer (layer 1) versatility includes:

- Enabling and disabling of Ethernet ports.
- Auto negotiation of port speed and duplex mode for all 10/100 Ethernet ports.
- Manual setting of port speed and duplex mode for all 10/100 Ethernet ports.
- Link up and link down triggers.
- Port trunking.
- Packet storm protection.
- Port mirroring.
- Support for SNMP management

Enabling and Disabling Switch Ports

An switch port that is enabled is available for packet reception and transmission. Its administrative status in the Interfaces MIB is UP. Conversely, an Ethernet port that is disabled is not available for packet reception and transmission. It will not send or receive any frames; incoming STP BPDU packets are discarded. Its administrative status in the Interfaces MIB is DOWN. Every Ethernet port on the switch is enabled by default. Disabling a switch port does not affect the STP operation on the port. Enabling a switch port will allow the port to participate in spanning tree negotiation. A switch port that has been disabled by the Port Security feature cannot be enabled using the ENABLE SWITCH PORT command.

To enable or disable a switch port, use the commands:

```
ENABLE SWITCH PORT={port-list|ALL}
DISABLE SWITCH PORT={port-list|ALL}
```

Resetting Ethernet ports at the hardware level discards all frames queued for reception or transmission on the port, and restarts autonegotiation of port speed and duplex mode. Ports are reset using the command:

```
RESET SWITCH PORT={port-list|ALL} [COUNTER]
```

To display information about switch ports, use the command:

```
SHOW SWITCH PORT[={port-list|ALL}]
```

Figure 8: Example output from the SHOW SWITCH PORT command.

```
Switch Port Information
------------------------------------------------------
Port ......................... 1
  Description.................... To intranet hub, port 4
  Status ........................ ENABLED
  Link state .................... Up
  UpTime ........................ 00:10:49
  Port Media Type ............... ISO8802-3 CSMACD
  Configured speed/duplex ....... Autonegotiate
  Actual speed/duplex ........... 100 Mbps, full duplex
  Acceptable Frame Types ........ Admit All Frames
  Broadcast rate limit .......... 1000/s
  Multicast rate limit .......... -
  DLF rate limit ................ -
  Learn limit ................... 20
  Intrusion action .............. Trap
  Current learned, lock state ... 15, not locked
  Mirroring ..................... Tx, to port 22
  Is this port mirror port ...... No
  Enabled flow control(s) ....... Jamming
                                  Pause
  Send tagged pkts for VLAN(s) .. marketing (87)
                                  sales (321)
  Port-based VLAN ............... accounting (42)
  Ingress Filtering ............. OFF
  Trunk Group ................... -
  STP ........................... company
------------------------------------------------------
```

.

Table 3: Parameters in the output of the SHOW SWITCH PORT command

Parameter	Meaning
Port	The number of the switch port.
Description	A description of the port.
Status	The state of the port; one of "ENABLED" or "DISABLED".
Link state	The link state of the port, one of "Up" or "Down".
Uptime	The count in hours:minutes:seconds of the elapsed time since the port was last reset or initialised.
Port Media Type	The MAC entity type as defined in the MIB object ifType.
Configured speed/duplex	The port speed and duplex mode configured for this port. One of "Autonegotiate" or a combination of a speed (one of "10 Mbps", "100 Mbps" or "1000 Mbps") and a duplex mode (one of "half duplex" or "full duplex").

Table 3: Parameters in the output of the SHOW SWITCH PORT command

Parameter	Meaning
Actual speed/duplex	The port speed and duplex mode that this port is actually running at. A combination of a speed (one of "10 Mbps", "100 Mbps" or "1000 Mbps") and a duplex mode (one of "half duplex" or "full duplex").
Acceptable Frames Types	The value of the Acceptable Frames Type parameter, one of: "Admit All Frames" or "Admit Only VLAN-tagged Frames".
Broadcast rate limit	The limit of the rate of reception of broadcast frames for this port, in frames per second.
Multicast cast rate limit	The limit of the rate of reception of multicast frames for this port, in frames per second.
DLF rate limit	The limit of the rate of reception of DLF (destination lookup failure) frames for this port, in frames per second.
Learn limit	The number of MAC addresses that may be learned for this port. Once the limit is reached, the port is locked against any new MAC addresses. One of "None" or a number from 1 to 256.
Intrusion action	The action taken on this port when a frame is received from an unknown MAC address when the port is locked. One of "None", "Discard", "Trap" or "Disable".
Current learned, lock state	The number of MAC addresses currently learned on this port and the state of locking for this port. The lock state is one of "not locked", "locked by limit" or "locked by command".
Mirroring	The traffic mirroring for traffic in and out of this port. One of "None", "Rx" (for traffic received by this port), "Tx" (for traffic sent on this port) or "Both". The port to which mirrored frames are being sent is also displayed.
Is this port mirror port	Whether or not this port is a mirror port. One of "No" or "Yes".
Enabled flow control(s)	Flow control parameters set for the port; zero, one or two of "Jamming" and "Pause". If flow control is implemented on the switch, then this kind of flow control is applied to the port.
Send tagged pkts for VLAN(s)	The name and VLAN Identifier (VID) of the tagged VLAN(s), if any, to which the port belongs.
Port-based VLAN	The name and VLAN Identifier (VID) of the port-based VLAN to which the port belongs.
Ingress Filtering	The state of Ingress Filtering: one of "ON" or "OFF".
Trunk Group	Name of trunk group to which the port belongs, if any.
STP	The name of the STP to which the port belongs.

Autonegotiation of Port Speed and Duplex Mode

Each of the switch ports can operate at either 10 Mbps or 100 Mbps, in either full duplex or half duplex mode. In full duplex mode a port can transmit and receive data simultaneously, while in half duplex mode the port can either transmit or receive, but not at the same time. This versatility makes it possible to connect devices with different speeds and duplex modes to different ports on the switch. Such versatility also requires that each port on the switch know

which speed and mode to use. Autonegotiation allows the ports to adjust their speed and duplex mode to accommodate the devices connected to them. Each switch port can be either configured with a fixed speed and duplex mode, or configured to autonegotiate speed and duplex mode with a device connected to it to determine a speed and mode that will allow successful transmission. An autonegotiating port will adopt the speed and duplex mode required by devices connected to it. If another autonegotiating device is connected to the switch, they will negotiate the highest possible common speed and duplex mode (Table 4). Setting the port to a fixed speed and duplex mode allows it to support equipment that cannot autonegotiate. Switch ports will autonegotiate by default when they are connected to a new device. To change this setting, use the command:

```
SET SWITCH PORT={port-list|ALL}
   SPEED={AUTONEGOTIATE|10MHALF|10MFULL|100MHALF|100MFULL|10
   00MHALF|1000MFULL}
```

Autonegotiation can also be activated at any time after this, on any port that is set to autonegotiate, by using the command:

```
ACTIVATE SWITCH PORT={port-list|ALL} AUTONEGOTIATE
```

On the first switch, the gigabit uplink ports always use 1000 Mbps speed and operate in full duplex mode, but these ports can also autonegotiate with peers in order to successfully pass the negotiation phase to get to successful operation.

Table 4: Autonegotiation preferences for Ethernet ports

Preference	10/100 Ethernet switch ports	Gigabit Ethernet uplink ports
Highest	100 Mbps, Full duplex	1000Mbps Full duplex
	100 Mbps, Half duplex	
	10Mbps, Full duplex	
Lowest	10Mbps, Half duplex	

The SHOW SWITCH PORT command displays the port speed and duplex mode settings.

Port Trunking

Port trunking, also known as port bundling or link aggregation, allows a number of ports to be configured to join together to make a single logical connection of higher bandwidth. This can be used where a higher performance link is required, and makes links even more reliable.

The switch supports up to 6 trunk groups, of up to 8 switch ports each. The two gigabit Ethernet ports can also be grouped together to form a trunk group. It is not possible for a trunk group to include both 10/100 Ethernet and gigabit Ethernet ports. Ports in the trunk group do not have to be contiguous. Port trunking is supported between AR800 Series and Rapier switches, and may be compatible with trunking algorithms on third party devices.

Port trunk groups are created and destroyed on the switch using the commands:

```
CREATE SWITCH TRUNK=trunk [PORT=port-list]
   [SELECT={MACSRC|MACDEST|MACBOTH|IPSRC|IPDEST|IPBOTH}]
   [SPEED={10M|100M|1000M}]
```

```
DESTROY SWITCH TRUNK=trunk
```

Port trunk groups can only be destroyed on the switch if no ports belong to them.

All the ports in a trunk group must belong to the same VLAN. Ports in a trunk group can be added to other VLANs, either as individual ports or as an entire group. A port in a trunk group cannot be deleted from any of the VLAN(s) to which the whole trunk group belongs, unless it is first removed from the trunk group. The members of a trunk group can be specified when it is created, and ports can be added to or removed from a trunk group using the commands:

```
ADD SWITCH TRUNK=trunk PORT=port-list

DELETE SWITCH TRUNK=trunk PORT={port-list|ALL}
```

Ports which are members of a trunk group must operate in full duplex mode. When a port is added to a trunk group, the speed setting for the group overrides the speed setting previously configured for the port. When a port is removed from a trunk group, the port returns to its previously configured speed and duplex mode settings. The speed of the trunk group can either be specified when it is created, or set using the command:

```
SET SWITCH TRUNK=trunk
    [SELECT={MACSRC|MACDEST|MACBOTH|IPSRC|IPDEST|IPBOTH}]
    [SPEED={10M|100M|1000M}]
```

The SELECT parameter specifies the port selection criterion for the trunk group. Each packet to be sent on the trunk group is checked, using the selection criterion, and a port in the trunk group chosen down which to send the packet. If MACSRC is specified, the source MAC address is used. If MACDEST is specified, the destination MAC address is used. If MACBOTH is specified, both source and destination MAC addresses are used. If IPSRC is specified, the source IP address is used. If IPDEST is specified, the destination IP address is used. If IPBOTH is specified, both the source and destination IP addresses are used. The user of the switch should choose the value of this parameter to try to spread out the load as evenly as possible on the trunk group. The default for this parameter is MACDEST.

The SPEED parameter specifies the speed of the ports in the trunk group. For gigabit ports, only the value 1000M is allowed. For switch ports, values of 10M and 100M are allowed. The default is 100M. When a port is added to a trunk group, its current speed and duplex mode settings are ignored and the port uses the speed of the trunk group and full duplex mode.

To display information about trunks on the switch, use the command:

```
SHOW SWITCH TRUNK[=trunk]
```

To display the VLANs to which the ports in the trunk groups belong, use the command:

```
SHOW VLAN[=ALL]
```

Port trunking must be configured on both ends of the link, or network loops may result.

Packet Storm Protection

The packet storm protection feature allows the user to set limits on the reception rate of broadcast, multicast and destination lookup failure packets. The software allows separate limits to be set for each port, beyond which each of the different packet types are discarded. The software also allows separate limits to be set for each of the packet types. Which of these options can be implemented depends on the model of switch hardware.

By default, packet storm protection is set to NONE, that is, disabled. It can be enabled, and each of the limits can be set using the command:

```
SET SWITCH PORT=port-list [BCLIMIT={NONE|limit}]
    [DLFLIMIT={NONE|limit}] [MCLIMIT={NONE|limit}]
```

For the Rapier 16 and 24-port switches, packet storm protection limits cannot be set for each individual port on the switch, but can be set for each processing block of ports. The processing blocks are sets of 8 ports (e.g. as many as are applicable of ports 1-8, 9-16 and 17-24) and each uplink port is a further processing block. Therefore, a 16-port switch has four processing blocks and a 24-port switch has five. The two uplink ports are numbered sequentially after the last port, and therefore are 17 and 18 for a 16-port, 25 and 26 for a 24-port switch. Only one limit can be set per processing block, and then applies to all three packet types. Thus each of the packet types are either limited to this value, or unlimited (NONE).

For the Rapier G6 series switches, each port is a processing block, and therefore packet storm protection limits can be set for each port individually.

The BCLIMIT parameter specifies a limit on the rate of reception of broadcast packets for the port(s). The value of this parameter represents a per second rate of packet reception above which packets will be discarded, for broadcast packets. If the value NONE or 0 is specified, then packet rate limiting for broadcast packets is turned off. If any other value is specified, the reception of broadcast packets will be limited to that number of packets per second. See the note below for important information about packet rate limiting. The default value for this parameter is NONE.

The DLFLIMIT parameter specifies a limit on the rate of reception of destination lookup failure packets for the port. The value of this parameter represents a per second rate of packet reception above which packets will be discarded, for destination lookup failure packets. If the value NONE or 0 is specified, then packet rate limiting for destination lookup failure packets is turned off. If any other value is specified, the reception of destination lookup failure packets will be limited to that number of packets per second. See the note after the BCLIMIT parameter description for important information about packet rate limiting. The default value for this parameter is NONE. If packet storm protection limits are set on the switch, the PORT parameter must specify complete processing blocks.

A destination lookup failure packet is one for which the switch hardware does not have a record of the destination address of the packet, either Layer 2 or Layer 3 address. These packets are passed to the CPU for further processing, so limiting the rate of reception of these packets may be a desirable feature to improve system performance.

The MCLIMIT parameter specifies a limit on the rate of reception of multicast packets for the port. The value of this parameter represents a per second rate of packet reception above which packets will be discarded, for multicast packets.

If the value NONE or 0 is specified, then packet rate limiting for multicast packets is turned off. If any other value is specified, the reception of multicast packets will be limited to that number of packets per second. See the note after the BCLIMIT parameter description for important information about packet rate limiting. The default value for this parameter is NONE. If packet storm protection limits are set on the switch, the PORT parameter must specify complete processing blocks.

The ability of the switch to limit packet reception rates for different classes of packets is dependent on the particular switch hardware. In particular, groups of ports may have to have the same limits set, and the same limit may be set for the different types of packets, depending on the hardware. Whenever packet rate limits are set on switches which have this type of constraint, the latest parameter values entered will supersede earlier values. When a command entered for specified ports changes the parameters for other ports, a message will indicate these changes.
For the Rapier 16 and 24-port switches, packet storm protection limits cannot be set for each individual port on the switch, but can be set for each processing block of ports. The processing blocks are sets of 8 ports (e.g. as many as are applicable of ports 1-8, 9-16 and 17-24) and each uplink port is a further processing block. Therefore, a 16-port switch has four processing blocks and a 24-port switch has five. The two uplink ports are numbered sequentially after the last port, and therefore are 17 and 18 for a 16-port and 25 and 26 for a 24-port switch. Only one limit can be set per processing block, and then applies to all three packet types. Thus each of the packet types are either limited to this value, or unlimited (NONE).
For the Rapier G6 series switches, each port is a processing block, and therefore packet storm protection limits can be set for each port individually.

The SHOW SWITCH PORT command displays the packet storm protection settings (Figure 8 on page 28).

```
SHOW SWITCH PORT=port-list
```

Port Mirroring

Port mirroring allows traffic being received and transmitted on a switch port to be sent to another switch port, the mirror port, usually for the purposes of capturing the data with a protocol analyser. This mirror port is the only switch port which belongs to no VLANs, and therefore does not participate in any other switching. Before the mirror port can be set, it must be removed from all VLANs except the default VLAN. The port cannot be part of a trunk group.

To set the mirror port (and remove it from the default VLAN) use the command:

```
SET SWITCH MIRROR={NONE|port}
```

If another port was previously set as the mirror port, this command returns the previous mirror port to the default VLAN as an untagged port. Return this port to any VLANs to which it should belong, using the ADD VLAN PORT command, or set it as a tagged port using the SET VLAN PORT command if required.

Either traffic received on a port or traffic transmitted by the port, or both, can be mirrored. This setting and the source port(s) from which traffic is sent to the mirror port are specified using the command:

```
SET SWITCH PORT={port-list|ALL} MIRROR={NONE|RX|TX|BOTH}
```

Mirroring four or more ports may significantly reduce switch performance.

The MIRROR parameter specifies the role of these port(s) as a source of mirror traffic. If NONE is specified, no traffic received or sent on these port(s) will be mirrored. If RX is specified, all traffic received on these port(s) will be mirrored. If TX is specified, all traffic transmitted on these port(s) will be mirrored. If BOTH is specified, all traffic received and transmitted will be mirrored. Traffic will actually only be mirrored if there is a mirror port defined and if mirroring is enabled. The default is NONE.

To send packets that match particular criteria to the mirror port, first create a filter match using the command:

```
ADD SWITCH L3FILTER MATCH
```

Then create a filter entry with the ACTION parameter set to SENDMIRROR, using the command:

```
ADD SWITCH L3FILTER=filter-id ENTRY ACTION=SENDMIRROR.
```

By default mirroring is disabled, no mirror port is set, and no source ports are set to be mirrored. Mirroring can only be enabled after the switch mirror port has been set to a valid port. If mirroring has been enabled but the switch mirror port is set to NONE, then mirroring will be disabled. Mirroring is enabled and disabled using the commands:

```
ENABLE SWITCH MIRROR

DISABLE SWITCH MIRROR
```

The SHOW SWITCH PORT and SHOW SWITCH commands display the switch and port mirroring settings.

Port security

The port security feature allows control over the stations connected to each switch port, by MAC address. If enabled on a port, the switch will learn MAC addresses up to a user-defined limit from 1 to 256, then lock out all other MAC addresses. One of the following options can be specified for the action taken when an unknown MAC address is detected on a locked port:

- Discard the packet and take no further action,
- Discard the packet and notify management with an SNMP trap,
- Discard the packet, notify management with an SNMP trap and disable the port.

To enable port security on a port, set the limit for learned MAC addresses to a value greater than zero, and specify the action to take for unknown MAC addresses on a locked port. To disable port security on a port, set the limit for learned MAC addresses to zero or NONE. Port security can be enabled or disabled on a port using the command:

```
SET SWITCH PORT={port-list|ALL} LEARN={NONE|0|1..256}
   [INTRUSIONACTION={NONE|DISCARD|TRAP|DISABLE}]
```

The INTRUSIONACTION parameter specifies the action taken when the port(s) receive packets from addresses which are not part of the learned list of addresses as specified by the LEARN parameter. If DISCARD is specified, packets received from MAC addresses not on the port's learn list will be

discarded. If TRAP is specified, packets received from MAC addresses not on the port's learn list will be discarded and an SNMP trap will be generated. If DISABLE is specified, the first time a packet is received from a MAC address not on the port's learn list, it will be discarded, an SNMP trap will be generated and the port(s) will be disabled. To re-enable the port, disable the Port Security function on the port. The default value for this parameter is DISCARD.

If INTRUSIONACTION is set to TRAP or DISABLE, a list of MAC addresses for devices that are active on a port, but which are not allowed or learned for the port, can be displayed using the command:

```
SHOW SWITCH PORT={port-list|ALL} INTRUSION
```

Figure 8-1: Example output from the SHOW SWITCH PORT INTRUSION command.

```
Switch Port Information
--------------------------------------------------------------------------------
Port 2 -    13 intrusion(s) detected
    00-00-c0-1d-2c-f8  00-90-27-87-a5-22  00-00-cd-01-00-4a
    00-d0-b7-4d-93-c0  08-00-5a-a1-02-3f  00-d0-b7-d5-5f-a9
    00-b0-d0-20-d1-01  00-90-99-0a-00-49  00-10-83-05-72-83
    00-00-cd-00-45-9e  00-00-c0-ad-a3-d0  00-a0-24-8e-65-3c
    00-90-27-32-ad-61
--------------------------------------------------------------------------------
```

A switch port can be manually locked before it reaches the learning limit, by using the command:

```
ACTIVATE SWITCH PORT={port-list|ALL} LOCK
```

Addresses can be manually added to a port locked list up to a total of 256 MAC addresses, and the learning limit can be extended to accommodate them, by using the command:

```
ADD SWITCH FILTER ACTION={FORWARD|DISCARD} DESTADDRESS=macadd
   PORT=port [ENTRY=entry] [LEARN] [VLAN={vlanname|1..4094}]
```

Learned addresses on locked ports can be saved as part of the switch configuration, so that they will be part of the configuration after a power cycle, using the command:

```
CREATE CONFIG=filename
```

If the configuration is not saved when there is a locked list for a port, the learning process begins again after the router is restarted.

Virtual LANs

A Virtual LAN is a software-defined broadcast domain. The switch's VLAN feature allows the network to be segmented by software management, improving network performance. Workstations, servers, and other network equipment connected to the switch can be grouped according to similar data and security requirements. Several VLANs can be connected to the same switch.

Devices that are members of a VLAN only exchange data with each other through the switching capabilities of the switch. Further flexibility can be gained by using VLAN tagging. To exchange data between devices in separate VLANs, the switch's routing capabilities are used. VLAN status information,

indicating whether a VLAN is up or down, is passed to the Internet Protocol (IP) module. IP uses this information to determine route availability.

By default the switch is configured to include all ports as untagged members of a single default VLAN, with no VLAN tagging required on incoming frames, or added to outgoing frames. This default VLAN cannot be deleted from the switch. If all the devices on the physical LAN are to belong to the same logical LAN, that is, the same broadcast domain, then the default settings will be acceptable, and no additional VLAN configuration is required.

The ability to decouple logical broadcast domains from the physical wiring topology offers several advantages, which include:

- Workstations can be grouped logically or functionally, regardless of their physical location on the network.
- VLAN memberships can be changed at any time by software configuration, without moving the workstations physically, or by simply moving a cable from one port to another.
- By using VLAN tagging, network servers or other network resources can be shared between different work groups without losing data isolation or security.
- One port on the switch can be configured as an uplink to another 802.1Q-compatible switch. By using VLAN tagging, this one port can carry traffic from all VLANs on the switch. (With port based VLANs, one uplink port is required to uplink each VLAN to another switch.)

VLANs can consist of simple logical groupings of untagged ports, in which the ports receive and transmit untagged packets. Alternatively, VLANs can include tagged ports, which add VLAN tags to packets they transmit. A port can transmit either untagged packets or VLAN tagged packets to a VLAN of which it is a member, but not both. A port can be tagged for more than one VLAN, so that a single port can be used to uplink several VLANs to another compatible switch.

A VLAN can contain a mixture of VLAN tagged and untagged ports.

The switch is VLAN aware, in that it can accept VLAN tagged frames, and supports the VLAN switching required by such tags. A network can contain a mixture of VLAN aware devices, for instance other 802.1Q compatible switches, and VLAN unaware devices, for instance, workstations and legacy switches that do not support VLAN tagging. The switch can be configured to send VLAN tagged or untagged frames on each port, depending on whether or not the devices connected to the port are VLAN aware. By assigning a port to two different VLANs, to one as an untagged port and to another as a tagged port, it is possible for the port to transmit both VLAN-tagged and untagged frames. A port can be untagged for zero or one VLAN, and can be tagged for zero or more different VLANs. A port must belong to a VLAN at all times unless the port has been set as the mirror port for the switch.

A port can belong to only one Spanning Tree entity (STP), and STP membership is per VLAN. A port cannot be added to a VLAN that is in a different STP from the VLANs to which the port already belongs, with one exception. The exception is that an untagged port in the default VLAN, that is not tagged for any other VLANs, can be moved from the default VLAN to any other VLAN in any STP.

Static and dynamic VLANs

All VLANs created by the user on the command line are static VLANs. The default VLAN is also a static VLAN.

Dynamic VLANs are created by GVRP, a GARP application whose purpose is to propagate VLAN information between VLAN aware switches. These dynamic VLANs are entitled gvrpxxx, where xxx is the VLAN's VLAN identifier. Dynamic VLANs will only be created if GVRP is enabled on the switch. GVRP is disabled by default.

All static VLANs except for the default VLAN can be destroyed by the user. Dynamic VLANs cannot be directly destroyed by the user, but may be destroyed according to the operations of GVRP by using the RESET GARP command or by disabling the GVRP instance.

The user can add, delete or modify ports belonging to any static VLAN. The user cannot add, delete or modify ports belonging to a dynamic VLAN. Dynamic VLANs created by GVRP only include tagged ports.

A port must belong to at least one static VLAN.

Creating VLANs Without VLAN Tags

VLANs that do not send any VLAN-tagged frames are logical groupings of ports. Any devices connected to the member ports share a common broadcast domain. The switch only forwards the traffic in a VLAN to the member ports.

Before any VLAN configuration has been entered, the switch has one default VLAN, which is initially configured to send untagged packets over all its member ports. More such VLANs can be created on the switch at any time. Each new VLAN is created with a VLAN name that is unique in the switch, and a VLAN Identifier (VID) that uniquely identifies the VLAN on the physical LAN. The default VLAN always has a VID of 1.

VLANs are created with the commands:

```
CREATE VLAN=vlanname VID=2..4094
```

The VLAN parameter specifies a unique name for the VLAN. This name can be more meaningful than the VID, to make administration easier. The VLAN name is only used within the switch; it is not transmitted to other VLAN-aware devices, or used in the Forwarding Process or kept in the Forwarding Database.

The VID parameter specifies a unique VLAN IDentifier for the VLAN. If VLAN-tagged ports are added to this VLAN, the specified VID is used in the VID field of the tag in outgoing frames. If VLAN-untagged ports are added to this VLAN, the specified VID only acts as an identifier for the VLAN in the Forwarding Database. The default port based VLAN has a VID of 1.

By default, all the ports on the switch belong to the default VLAN, except the mirror port if there is one configured. Any port can be added untagged to another VLAN, and is then automatically removed from the default VLAN. A port can only be untagged for one VLAN. A port can only be added to the default VLAN as an untagged port if it is not an untagged port for another VLAN.

Untagged ports are added to VLANs using the command:

```
ADD VLAN={vlanname|1..4094} PORT={port-list|ALL}
```

A VLAN untagged frame received on a port will be associated with the VLAN to which the port belongs as an untagged member.

VLANs are destroyed using the command:

```
DESTROY VLAN={vlanname|2..4094|ALL}
```

An untagged port deleted from a VLAN is returned to the default VLAN if the port does not transmit VLAN tagged frames for another static VLAN.

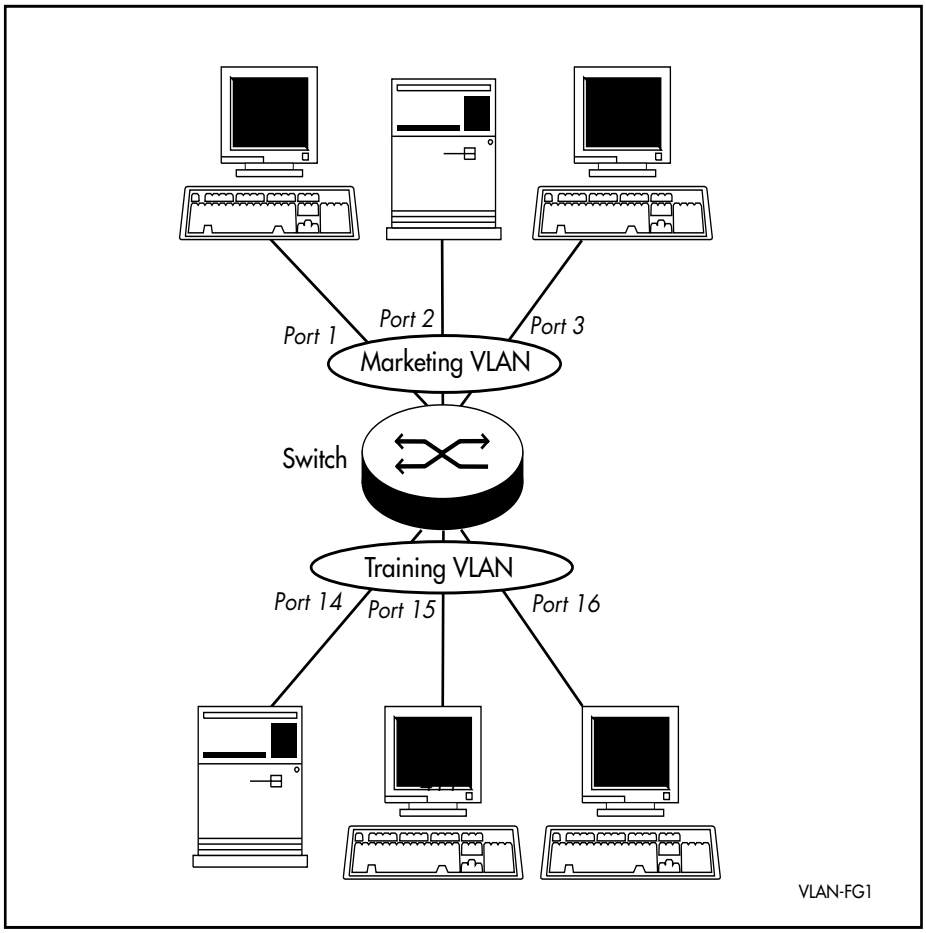
Untagged ports are removed from VLANs using the command:

```
DELETE VLAN={vlanname|1..4094} PORT={port-list|ALL}
```

An untagged port can only be deleted from the default VLAN if the port transmits VLAN tagged frames for another static VLAN.

Figure 9 shows two VLANs. Ports 1-3 belong to one broadcast domain, the *marketing* VLAN, and ports 14-16 belong to another broadcast domain, the *training* VLAN. The switch acts as two separate bridges: one that forwards traffic between the ports belonging to the *marketing* VLAN, and a second one that forwards traffic between the ports belonging to the *training* VLAN. Devices in the *marketing* VLAN can only communicate with devices in the *training* VLAN by using the switch's routing functions.

Figure 9: VLANS with untagged ports



To display the VLANs configured on the switch, use the command:

```
SHOW VLAN[={vlanname|1..4094|ALL}]
```

Figure 10: Example output from the SHOW VLAN command.

```
VLAN Information
---------------------------------------------------------------
---------------
 Name ............... default
 Identifier ......... 1
 Status ............. static
 Untagged ports ..... 1,3-23
 Tagged ports ....... None
 Spanning Tree ...... default
 Trunk ports ........ None
 Mirror port ........ None
 Attachments:
 Module         Protocol       Format   Discrim    MAC address
 ------------------------------------------------------------
--------
 GARP             Spanning tree    802.2     42             -
 ------------------------------------------------------------
--------

 Name ............... v2
 Identifier ......... 2
 Status ............. dynamic
 Untagged ports ..... 2,24
 Tagged ports ....... None
 Spanning Tree ...... default
 Trunk ports ........ None
 Attachments:
 Module         Protocol       Format   Discrim    MAC address
 ------------------------------------------------------------
--------
 GARP             Spanning tree    802.2     42             -
 ------------------------------------------------------------
--------
```

Table 5: Parameters displayed in the output of the SHOW VLAN command

Parameter	Meaning
Name	The name of the VLAN.
Identifier	The numerical VLAN identifier of the VLAN.
Status	The status of the VLAN, either dynamic or static.
Untagged Ports	A list of untagged ports that belong to the VLAN.
Tagged Ports	A list of tagged ports that belong to the VLAN.
Spanning Tree	The name of the Spanning Tree Protocol to which the VLAN belongs.
Trunk ports	The list of switch ports which belong to trunk groups. This field is displayed if any port in the VLAN also belongs to a trunk group.
Mirror port	The mirror port for the switch, or "None". Displayed for the default VLAN only.
Attachments	This section contains information about attachments to the VLAN made by other modules in the switch.
Module	The name of the software module attached to the VLAN.

Table 5: Parameters displayed in the output of the SHOW VLAN command

Parameter	Meaning
Protocol	The name of the protocol, which is determined from the format and identification number.
Format	The encapsulation format specified by the module.
Discrim	The discriminator specified by the module to identify which packets of the given format should be received.
MAC Address	The Media Access Control source address for which the module wishes to receive packets. This is commonly known as the Ethernet address.

There are some disadvantages to using VLANs with untagged ports only:

- It is difficult to share network resources, such as servers and printers, across several VLANs. The routing functions in the switch must be configured to interconnect using untagged ports only.
- A VLAN that spans several switches requires a port on each switch for the interconnection of the various parts of the VLAN. If there are several VLANs in the switch that span more than one switch, then many ports are occupied with connecting the VLANs, and so are unavailable for other devices.

These disadvantages can be overcome with the versatility of VLAN tagging.

VLAN Tagging

VLAN tagging provides the advantages of more efficient and flexible use of switch ports and network resources, while maintaining the level of security given by port-based VLANs. With VLAN tagging, a port can belong to several VLANs. This means that network resources can be shared between different VLANs by configuring their ports to belong to more than one VLAN. Only one port is required on each switch to uplink (trunk) all VLAN traffic between two VLAN aware switches, as this port can be configured to belong to all VLANs on the switch.

Support for VLAN tagging is implemented in the switch according to IEEE Standard 802.1Q. Just as with untagged ports, tagged ports in a VLAN belong to the VLAN's broadcast domain. A VLAN Identifier (VID) is defined for each VLAN, and this VID is used to switch traffic through a VLAN aware network so that frames are only transmitted on ports belonging to the VLAN. Other vendors' VLAN aware devices on the network can be configured to accept traffic from one or more VLANs. A VLAN-aware server can be configured to accept traffic from many different VLANs, and then return data to each VLAN without mixing or leaking data into the wrong VLANs.

Every frame admitted by the switch has a VID associated with it, either because it already had a VLAN tag when it arrived, or because the VLAN for which the incoming port is untagged was associated with the frame when it was admitted. The switch only forwards the frame over those ports that belong to the VLAN specified by this VID. When the switch forwards a frame over a tagged port to another VLAN-aware device (for instance, another switch), it adds a VLAN tag (the same VID) to the frame. When the switch forwards the frame over an untagged port to a VLAN-unaware device, it transmits the frame as a VLAN-untagged frame, not including the VID in the frame.

VLANs to be used with VLAN tags are created and destroyed in the same way as VLANs with only untagged ports, by using the commands:

```
CREATE VLAN=vlanname VID=2..4094

DESTROY VLAN={vlanname|2..4094|ALL}
```

A VLAN may have VLAN-aware devices connected to some ports that require VLAN tagging, and legacy devices connected to other ports that cannot accept VLAN tags. Whether VLAN tagged or untagged frames are transmitted on a port for a particular VLAN is determined when the port is added to that VLAN. Ports are added to and deleted from VLANs using the commands:

```
ADD VLAN={vlanname|1..4094} PORT={port-list|ALL}
    [FRAME=TAGGED|UNTAGGED]

DELETE VLAN={vlanname|1..4094} PORT={port-list|ALL}
```

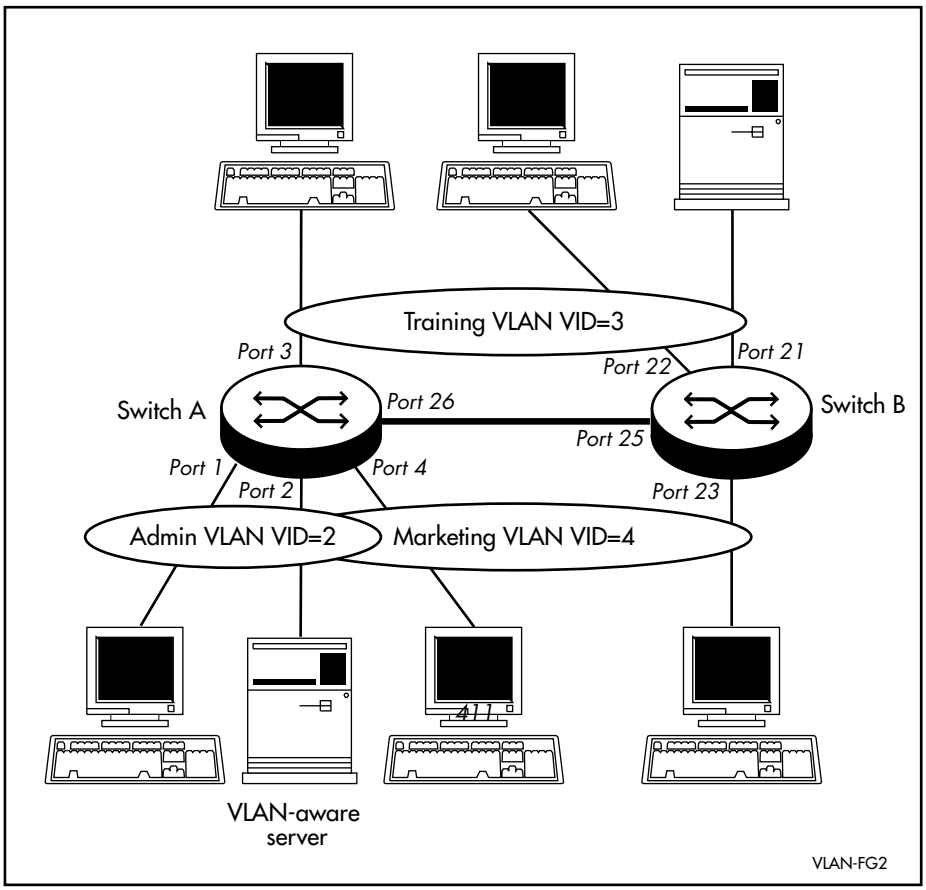
The FRAME parameter specifies whether VLAN tag headers are included in frames transmitted on the specified ports. If TAGGED is specified, a VLAN tag is added to frames prior to transmission. The port is then called a tagged port for this VLAN. If UNTAGGED is specified, the frame is transmitted without a VLAN tag. The port is then called an untagged port for this VLAN. A port can be untagged for one and only one of the VLANs to which it belongs, or for none of the VLANs to which it belongs. A port can have the FRAME parameter set to TAGGED for zero or more VLANs to which it belongs. It is not possible to add an untagged port to a VLAN if the port is already present in any other port-based VLAN except the default VLAN. If the port is an untagged member of the default VLAN, adding it untagged to another VLAN deletes it from the default VLAN. The default setting is UNTAGGED.

A port can be tagged (receive and send VLAN tagged frames) for some VLANs, and untagged for zero or one VLAN. A VLAN can have both tagged and untagged ports. But a particular port cannot transmit both tagged and untagged frames for the same VLAN (that is, it cannot be added to the same VLAN as both a tagged and an untagged port).

Figure 11 shows a network that must be configured with VLAN tagging, since the server on port 2 on Switch A belongs to both the *admin* and *marketing* VLANs. Using VLAN tags, port 26 on Switch A and port 25 on Switch B belong to both the *marketing* VLAN and the *training* VLAN, so devices on both VLANs can use this uplink.

Note that ports tagged for some VLANs and left in the default VLAN as untagged ports will transmit broadcast traffic for the default VLAN. If this is not required, the unnecessary traffic in the switch can be reduced by deleting those ports from the default VLAN.

Figure 11: Tagged VLANs



To display the VLANs configured on the switch, use the command:

```
SHOW VLAN[={vlanname|1..4094|ALL}]
```

Summary of VLAN Tagging Rules

When designing a VLAN and adding ports to VLANs, the following rules apply.

1. Each port, except for the mirror port, must belong to at least one VLAN. By default, a port is an untagged member of the default VLAN.
2. A port can be untagged for zero or one VLAN. A port that is untagged for a VLAN transmits frames destined for that VLAN without a VLAN tag in the Ethernet frame.
3. A port can be tagged for zero or more VLANs. A port that is tagged for a VLAN transmits frames destined for that VLAN with a VLAN tag, including the VID of the VLAN.
4. A port cannot be untagged and tagged for the same VLAN.
5. The mirror port, if there is one, is not a member of any VLANs.

Generic VLAN Registration Protocol (GVRP)

The GARP application GVRP allows routers in a network to dynamically share VLAN membership information, to reduce the need for statically configuring all VLAN membership changes on all switches in a network. See the *Generic Attribute Registration Protocol (GARP)* chapter in the *Rapier Switch Software Reference*.

Layer 2 Switching Process

The Layer 2 switching process comprises related but separate processes. The *Ingress Rules* admit or discard frames based on their VLAN tagging. The *Learning Process* learns the MAC addresses and VLAN membership of frames admitted on each port. The *Forwarding Process* determines which ports the frames are forwarded to, and the *Quality of Service* priority with which they are transmitted. Finally, the *Egress Rules* determine for each frame whether VLAN tags are included in the Ethernet frames that are transmitted. These processes assume that each station on the extended LAN has a unique data link layer address, and that all data link layer frames have a header which includes the source (sender's) MAC address and destination (recipient's) MAC address.

The Ingress Rules

When a frame first arrives at a port, the Ingress Rules for the port check the VLAN tagging in the frame to determine whether it will be discarded or forwarded to the Learning Process.

The first check depends on whether the *Acceptable Frame Types* parameter is set to *Admit All Frames* or to *Admit Only VLAN Tagged Frames*. A port that transmits only VLAN tagged frames, regardless of which VLAN the port belongs to, will be automatically set to Admit Only VLAN Tagged Frames. The user cannot change this setting. Frames with a null numerical VLAN Identifier (VID) are VLAN-untagged frames, or frames with priority tagging only.

Every frame received by the switch must be associated with a VLAN. If a frame is admitted by the Acceptable Frame Types parameter, the second part of the Ingress Rules associates each untagged frame admitted with the VID of the VLAN for which the port is untagged.

Every port belongs to one or more VLANs, and therefore every incoming frame will have a VID to show which VLAN it belongs to. The final part of the Ingress Rules depends on whether *Ingress Filtering* is enabled for the port. If Ingress Filtering is disabled, all frames are passed on to the Learning Process, regardless of which VLAN they belong to. If Ingress Filtering is enabled, frames are admitted only if they have the VID of a VLAN to which the port belongs. If they have the VID of a VLAN to which the port does not belong, they are discarded.

The default settings for the Ingress Rules are to Admit All Frames, and for Ingress Filtering to be OFF. This means that if no VLAN configuration has been done, all incoming frames pass on to the Learning Process, regardless of

whether or not they are VLAN tagged. The parameters for each port's Ingress Rules can be configured using the command:

```
SET SWITCH PORT={port-list|ALL} [ACCEPTABLE={VLAN|ALL}]
    [INFILTERING={ON|OFF}] [other-parameters...]
```

The ACCEPTABLE parameter sets the Acceptable Frame Types parameter, in the Ingress Rules, which controls reception of VLAN-tagged and VLAN-untagged frames on the port. If ALL is specified, then the Acceptable Frame Types parameter is set to Admit All Frames. If VLAN is specified, the parameter is set to Admit Only VLAN-tagged Frames, and any frame received that carries a null VLAN Identifier (VID) is discarded by the ingress rules. Untagged frames and priority-tagged frames carry a null VID. Untagged frames admitted according to the ACCEPTABLE parameter have the VID of the VLAN for which the port is untagged associated with them. The ACCEPTABLE parameter can only be set if the port is untagged for one VLAN. In this case, the default is ALL, admitting all tagged and untagged frames. If the port is tagged for all the VLANs to which it belongs, the ACCEPTABLE parameter is automatically set to VLAN, and cannot be changed to admit untagged frames.

The INFILTERING parameter enables or disables Ingress Filtering of frames admitted according to the ACCEPTABLE parameter, on the specified ports. Each port on the switch belongs to one or more VLANs. If INFILTERING is set to ON, Ingress Filtering is enabled: any frame received on a specified port is only admitted if the port belongs to the VLAN with which the frame is associated. Conversely, any frame received on the port is discarded if the port does not belong to the VLAN with which the frame is associated. Untagged frames admitted by the ACCEPTABLE parameter are admitted, since they have the numerical VLAN Identifier (VID) of the VLAN for which the port in an untagged member. If OFF is specified, Ingress Filtering is disabled, and no frames are discarded by this part of the Ingress Rules. The default setting is OFF.

To display the current Ingress Rules (Figure 8 on page 28), use the command:

```
SHOW SWITCH PORT=port-list
```

The Learning Process

The Learning Process uses an *adaptive learning* algorithm, sometimes called *backward learning*, to discover the location of each station on the extended LAN.

All frames admitted by the Ingress Rules on any port are passed on to the Forwarding Process if they are for destinations within the same VLAN. Frames destined for other VLANs are passed to the layer three protocol, for instance IP. For every frame admitted, the frame's source MAC address and numerical VLAN Identifier (VID) are compared with entries in the Forwarding Database for the VLAN (also known as a MAC address table, or a forwarding table) maintained by the switch. The Forwarding Database contains one entry for every unique station MAC address the switch knows in each VLAN.

If the frame's source address is not already in the Forwarding Database for the VLAN, the address is added and an ageing timer for that entry is started. If the frame's source address is already in the Forwarding Database, the ageing timer for that entry is restarted. By default, switch learning is enabled, and it can be disabled or enabled using the commands:

```
DISABLE SWITCH LEARNING
```

```
ENABLE SWITCH LEARNING
```

If the ageing timer for an entry in the Forwarding Database expires before another frame with the same source address is received, the entry is removed from the Forwarding Database. This prevents the Forwarding Database from being filled up with information about stations that are inactive or have been disconnected from the network, while ensuring that entries for active stations are kept alive in the Forwarding Database. By default, the ageing timer is enabled, and it can be disabled or enabled using the commands:

```
ENABLE SWITCH AGEINGTIMER

DISABLE SWITCH AGEINGTIMER
```

If switch learning is disabled and the ageing timer has aged out all dynamically learned filter entries, only statically entered MAC source addresses will be used to decide which packets to forward or discard. If the switch finds no matching entries in the Forwarding Database during the Forwarding Process, then all switch ports in the VLAN will be flooded with the packet, except the port on which the packet was received.

The default value of the ageing timer is 300 seconds (5 minutes), and this can be modified using the command:

```
SET SWITCH AGEINGTIMER=10..1000000
```

The Forwarding Database relates a station's (source) address to a port on the switch, and is used by the switch to determine from which port (if any) to transmit frames with a destination MAC address matching the entry in the station map.

To display the contents of the Forwarding Database, use the command:

```
SHOW SWITCH FDB [ADDRESS=macadd]
    [DISCARD={SOURCE|DESTINATION}] [HIT={YES|NO}]
    [L3={YES|NO}] [PORT={portlist|ALL}]
    [STATUS={STATIC|DYNAMIC}] [VLAN={vlanname|1..4094}]
```

To display general switch settings, including settings for switch learning and the switch aging timer, use the command:

```
SHOW SWITCH
```

The Forwarding Process

The Forwarding Process forwards received frames that are to be relayed to other ports in the same VLAN, filtering out frames on the basis of information contained in the station map and on the state of the ports. If a frame is received on the port for a destination in a different VLAN, it is either Layer 3 switched if it is an IP packet, or looked up in the Layer 3 routing tables (see the *Rapier Switch Software Reference*.)

Forwarding occurs only if the port on which the frame was received is in the Spanning Tree 'Forwarding' state. The destination address is then looked up in the Forwarding Database for the VLAN. If the destination address is not found, the switch floods the frame on all ports in the VLAN except the port on which the frame was received. If the destination address is found, the switch discards the frame if the port is not in the STP 'Forwarding' state, if the destination address is on the same port as the source address, or if there is a static filter entry for the destination address set to DISCARD ("*Layer 2 Filtering*" on page 46). Otherwise, the frame is forwarded on the indicated port.

This whole process can further be modified by the action of static switch filters. These are configurable filters which allow switched frames to be checked against a number of entries.

The Forwarding Process provides storage for queued frames to be transmitted over a particular port or ports. More than one transmission queue may be provided for a given port. Which transmission queue a frame is sent to is determined by the user priority tag in the Ethernet frame, and the Quality of Service mapping.

Layer 2 Filtering

The switch has a Forwarding Database, entries in which determine whether frames are forwarded or discarded over each port. Entries in this Forwarding Database are created dynamically by the Learning Process. A dynamic entry is automatically deleted from the Forwarding Database when its ageing timer expires. Filtering is specified in the IEEE 802.1D Standard "*Media Access Control (MAC) Bridges*".

The user can configure static switch filter entries using the command line interface. Static switch filter entries associate a MAC address with a VLAN and a port in the VLAN. When the switch receives a frame with a destination address and VLAN Identifier that match those of a static filter entry, the frame can be either forwarded to the port specified in the static filter entry, or discarded.

The Forwarding Database supports queries by the Forwarding Process as to whether frames with given values of the destination MAC address field should be forwarded to a given port.

To add or delete static switch filter entries, use the commands:

```
ADD SWITCH FILTER DESTADDRESS=macadd ACTION={FORWARD|DISCARD}
    PORT[=port-list] [ENTRY=entry] [VLAN={vlanname|1..4094}]

DELETE SWITCH FILTER ENTRY=entry-list
```

The switch automatically deletes static filter entries for a port if the port is deleted from the specified VLAN.

To display current static switch filter entries, use the command:

```
SHOW SWITCH FILTER [DESTADDRESS=macadd] [ENTRY=entry]
    [PORT=port-list] [VLAN={vlanname|1..4094}]
```

Figure 12: Example output from the SHOW SWITCH FILTER command.

```
 Switch Filters
-------------------------------------------------------------------------
 Entry             VLAN         Destination Address   Port  Action  Source
-------------------------------------------------------------------------
    0           default (1)       aa-ab-cd-00-00-01     1  Forward  static
    1           default (1)       aa-ab-cd-00-00-02     1  Forward  static

    0           marketing (2)     aa-ab-cd-00-00-01     2  Discard  static
    1           marketing (2)     aa-ab-cd-00-00-02     2  Discard  learn
-------------------------------------------------------------------------
```

Table 6: Parameters in the output of the SHOW SWITCH FILTER command

Parameter	Meaning
Entry	The number identifying the filter entry.
Destination Address	The destination MAC address for the entry.
VLAN	The VLAN name and identifier for the entry.
Port	The outbound port to match for the filter entry to be applied.
Action	The action specified by the filter entry; one of "Forward" or "Discard".
Source	This parameter is either "static" (indicating the filter is a static filter) or "learned" (indicating the filter is present either because it has been added with the LEARN parameter of the SET SWITCH PORT command, or has been dynamically learned during normal intrusion detection operation).

For each VLAN, the destination MAC address of a frame to be forwarded is checked against the Forwarding Database. If there is no entry for the destination address and VLAN, the frame is transmitted on all ports in the VLAN that are in the 'Forwarding' or 'Disabled' states, except the port on which the frame was received. This process is referred to as *flooding*. If an entry is found in the Forwarding Database, but the entry is not marked as 'Forwarding' or the entry points to the same port the frame was received on, the frame is discarded. Otherwise, the frame is transmitted on the port specified by the entry in the Forwarding Database.

A dynamic entry is automatically deleted from the Forwarding Database when its ageing timer expires.

The Egress Rules

Once the Forwarding Process has determined which ports and transmission queues to forward a frame from, the Egress Rules for each port determine whether or not the outgoing frame is VLAN-tagged with its numerical VLAN Identifier (VID). (See "*Virtual LANs*" on page 35).

When a port is added to a VLAN, it is configured to transmit either untagged or VLAN tagged packets, using the command:

```
ADD VLAN={vlanname|1..4094} PORT={port-list|ALL}
    [FRAME={TAGGED|UNTAGGED}]
```

This setting can be changed for a port which is already part of a VLAN, using the command:

```
SET VLAN={vlanname|1..4094} PORT={port-list|ALL}
    FRAME={UNTAGGED|TAGGED}
```

Quality of Service

The switch hardware has a number of Quality of Service (QOS) *egress queues* that can be used to give priority to the transmission of some frames over other frames on the basis of their user priority tagging. The user priority field in an incoming frame (with value 0 to 7) determines which of the eight priority levels the frame is allocated. When a frame is forwarded, it is sent to a QOS egress queue on the port determined by the mapping of priority levels to QOS egress queues. All frames in the first QOS queue are sent before any frames in the second QOS egress queue, and so on, until frames in the last QOS egress queue, which are only sent when there are no frames waiting to be sent in any of the higher QOS egress queues.

The mapping between user priority and a QOS egress queue can be configured using the command:

```
SET SWITCH QOS=P1,P2,P3,P4,P5,P6,P7,P8
```

The switch has four QOS egress queues. It has a default mapping of priority levels to QOS egress queues as defined in *IEEE Standard 802.1Q* (Table 7).

Table 7: Default priority level to queue mapping for four QOS egress queues

Priority level	QOS Egress Queue
0	1
1	0
2	0
3	1
4	2
5	2
6	3
7	3

To display the mapping of user priority to QOS egress queues, use the command:

```
SHOW SWITCH QOS
```

Figure 13: Example output from the SHOW SWITCH QOS command

```
Priority Level       QOS egress queue
-------------------------------------
0 ................... 1
1 ................... 0
2 ................... 0
3 ................... 1
4 ................... 2
5 ................... 2
6 ................... 3
7 ................... 3
```

Table 8: Parameters in the output of the SHOW SWITCH QOS command

Parameter	Meaning
Priority level	The priority level of the frame.
QOS egress queue	The Quality Of Service egress queue that frames with this priority level join.

Spanning Tree Protocol (STP)

The Spanning Tree Protocol (STP) makes it possible to automatically disable redundant paths in a network to avoid loops, and enable them when a fault in the network means they are needed to keep traffic flowing. A sequence of LANs and switches may be connected together in an arbitrary physical topology resulting in more than one path between any two switches. If a loop exists, frames transmitted onto the extended LAN would circulate around the loop indefinitely, decreasing the performance of the extended LAN. On the other hand, multiple paths through the extended LAN provide the opportunity for redundancy and backup in the event of a bridge experiencing a fatal error condition.

The spanning tree algorithm ensures that the extended LAN contains no loops and that all LANs are connected by:

- Detecting the presence of loops and automatically computing a logical loop-free portion of the topology, called a *spanning tree*. The topology is dynamically pruned to a spanning tree by declaring the ports on a switch redundant, and placing the ports into a 'Blocking' state.
- Automatically recovering from a switch failure that would partition the extended LAN by reconfiguring the spanning tree to use redundant paths, if available.

Spanning Tree Port States

Each port can be in one of five Spanning Tree states, and one of two switch states. The Spanning Tree states (Table 9) affect the behaviour of ports whose switch state is enabled.

Table 9: Spanning tree port states

State	Meaning
DISABLED	STP operations are disabled on the port. The port can still switch if its switch state is enabled.
LISTENING	The port is enabled for receiving frames only.
LEARNING	The port is enabled for receiving frames only, and the Learning Process can add new source address information to the Forwarding Database.
FORWARDING	The normal state for a switch port. The Forwarding Process and the Spanning Tree entity are enabled for transmit and receive operations on the port.
BLOCKING	The Spanning Tree entity has disabled the Forwarding process for transmit and receive operations on the port, but the Spanning Tree entity itself remains enabled for transmit and receive operations on the port.

To display the STP state of the switch ports (Figure 15 on page 54), use the command:

```
SHOW STP PORT=port-list
```

A Rapier switch in default LAN configuration has a *default* Spanning Tree enabled, spanning only a single default VLAN, to which all ports belong. The switches in the LAN run a distributed Spanning Tree Algorithm to create a single Spanning Tree. In a network of Rapier switches with VLANs configured, all VLANs belong by default to a default Spanning Tree called *default*. Multiple Spanning Trees can be created with each Spanning Tree encompassing multiple VLANs (in networks switched exclusively by Rapier switches). For more information about multiple spanning trees, see the *Switching* chapter in the *Rapier Switch Software Reference*.

Configuring STP

By default, the switch has one *default* STP which cannot be destroyed. In most situations this default STP will suffice.

By default, all VLANs, and therefore all ports, belong to the *default* STP. To add or delete a VLAN and all the ports belonging to it from any other STP, use the commands:

```
ADD STP=stpname VLAN={vlanname|2..4094}

DELETE STP=stpname VLAN={vlanname|2..4094|ALL}
```

The default STP is disabled by default at switch start up, and STPs created by a user are disabled by default when they are created. An STP must be enabled before STP can be enabled or disabled on particular ports belonging to it. To enable or disable STPs, use the commands:

```
ENABLE STP{=stpname|ALL}

DISABLE STP={stpname|ALL}
```

The Spanning Tree Protocol uses three configurable parameters for the time intervals that control the flow of STP information on which the dynamic STP topology depends: the HELLOTIME, FORWARDDELAY and MAXAGE parameters. All switches in the same spanning tree topology must use the same values for these parameters, but can themselves be configured with different, and potentially incompatible time intervals. The parameter values actually used by each switch are those sent by the root bridge, and forwarded to all other switches by the designated bridges.

The FORWARDDELAY parameter sets the time, in seconds, used to control how fast a port changes its spanning state when moving towards the Forwarding state. The value determines how long the port stays in each of the Listening and Learning states which precede the Forwarding state. This value is only used when the switch is acting as the Root Bridge. Any switch not acting as the Root Bridge uses a dynamic value for the FORWARDDELAY set by the Root Bridge. The FORWARDDELAY, MAXAGE and HELLOTIME parameters are interrelated. See the note and formulae below. The default value for FORWARDDELAY is 15 seconds.

The HELLOTIME parameter sets the time, in seconds, between the transmission of switch spanning tree configuration information when the switch is the Root Bridge of the spanning tree or is trying to become the Root Bridge. The default value is 2 seconds.

The MAXAGE parameter sets the maximum age, in seconds, of Spanning Tree Protocol information learned over the network on any port before it is discarded. The default value is 20 seconds.

The FORWARDDELAY, MAXAGE and HELLOTIME parameters should be set according to the following formulae, as specified in IEEE Standard 802.1D:
2 x (FORWARDDELAY - 1.0 seconds) >= MAXAGE
MAXAGE >= 2 x (HELLOTIME + 1.0 seconds)

To modify the parameters controlling these time intervals, use the command:

```
SET STP={stpname|ALL} [FORWARDDELAY=4..30] [HELLOTIME=1..10]
    [MAXAGE=6..40] [other-parameters...]
```

The value of the PRIORITY parameter is used to set the writable portion of the bridge ID, i.e. the first two octets of the (8-octet long) Bridge Identifier. The remaining 6 octets of the bridge ID are given by the MAC address of the switches. The Bridge Identifier parameter is used in all configuration Spanning Tree Protocol packets transmitted by the switch. The first two octets, specified by the PRIORITY parameter, determine the switch's priority for becoming the *root bridge* or a *designated bridge* in the network, with a lower number indicating a higher priority. In fairly simple networks, for instance those with a small number of switches in a meshed topology, it may make little difference which switch is selected to be the root bridge, and no modifications may be needed to the default PRIORITY parameter, which has a default value of 32768. In more complex networks, one or more switches are likely to be more suitable candidates for the root bridge role, for instance by virtue of being more central in the physical topology of the network. In these cases the STP PRIORITY parameters for at least one of the switches should be modified.

To change the STP priority value, use the command:

```
SET STP={stpname|ALL} PRIORITY=0..65535
```

The PRIORITY parameter sets the priority of the switch to become the Root Bridge. The lower the value of the Bridge Identifier, the higher the priority. If the PRIORITY parameter is set, either by specifying the PRIORTY or DEFAULT parameters, the specified STP is initialised. Counters for the STP are not affected. The default value for PRIORITY is 32768.

To restore STP timer and priority defaults, use the command:

```
SET STP={stpname|ALL} DEFAULT
```

Changing the STP PRIORITY using either of the previous commands initialises the STP, so that elections for the root bridge and designated bridges begin again, without resetting STP counters. To display general information about STPs on the switch, use the command:

```
SHOW STP[={stpname|ALL}]
```

Figure 14: Example output from the SHOW STP command.

```
STP Information
-------------------------------------------------------------
Name ................. default
VLAN members ......... default (1)
                       marketing (3)
Status ............... ON
Number of Ports ....... 21
  Number Enabled ...... 0
  Number Disabled ..... 21
Bridge Identifier ..... 32768 : 00-00-cd-00-a9-a5
Designated Root ....... 32768 : 00-00-cd-00-a9-a5
Root Port ............. (n/a)
Root Path Cost ........ 0
Max Age ............... 20
Hello Time ............ 2
Forward Delay ......... 15
Switch Max Age ........ 20
Switch Hello Time ..... 2
Switch Forward Delay .. 15
Hold Time ............. 1
-------------------------------------------------------------
```

Table 10: Parameters in the output of the SHOW STP command

Parameter	Meaning
STP Name	The name of the Spanning Tree Protocol entity.
VLAN members	A list of the VLANs that are members of the STP. VLAN Identifiers are shown in brackets.
Status	The status of the STP; either ON or OFF.
Number of Ports	The number of ports belonging to the STP.
Number Enabled	The number of ports that have been enabled and are being considered by the Spanning Tree Algorithm.
Number Disabled	The number of ports that have been disabled and are not being considered by the Spanning Tree Algorithm.
Bridge Identifier	The unique Bridge Identifier of the switch. This parameter consists of two parts, one of which is derived from the unique Switch Address, and the other of which is the priority of the switch.
Designated Root	The unique Bridge Identifier of the bridge assumed to be the Root.
Root Port	The port number of the root port for the switch. If the switch is the Root Bridge this parameter is not valid and is not shown.
Root Path Cost	The cost of the path to the Root from this switch. If the switch is the Root Bridge this parameter is not valid and is not shown.
Max Age	The maximum age of received Configuration Message information before it is discarded.
Hello Time	The time interval between successive transmissions of the Configuration Message information by a switch which is the Root or which is attempting to become the Root.

Table 10: Parameters in the output of the SHOW STP command

Parameter	Meaning
Forward Delay	The time ports spend in the Listening state and Learning state before moving to the Learning or Forwarding state respectively. Also the value used for the ageing timer for the dynamic entries in the Forwarding Database while received Configuration Messages indicate a topology change.
Switch Max Age	The value of the Max Age parameter when this switch is the Root or is attempting to become the Root. This parameter is set by the MAXAGE parameter in the SET STP command.
Switch Hello Time	The value of the Hello Time parameter when this switch is the Root or is attempting to become the Root. This parameter is set by the HELLOTIME parameter in the SET STP command.
Switch Forward Delay	The value of the Forward Delay parameter when this switch is the Root or is attempting to become the Root. This parameter is set by the FORWARDDELAY parameter in the SET STP command.
Hold Time	The minimum time in seconds between the transmission of configuration BPDUs through a given LAN Port. The value of this fixed parameter is 1, as specified in IEEE Std 802.1D.

Each port has a port priority, with a default value of 128, used to determine which port should be the root port for the STP if two ports are connected in a loop. The lower number indicates the higher priority.

```
SET STP PORT={port-list|ALL} PORTPRIORITY=0..255 [other-
   parameters...]
```

The PORTPRIORITY parameter sets the value of the priority field contained in the port identifier. The Spanning Tree Algorithm uses the port priority when determining the root port for each switch. The port with the lowest value is considered to have the highest priority. The default value is 128. Each STP has its own independent PORTPRIORITY parameter for each member port.

Each port also has a path cost, which is used if the port is the root port for the STP on the switch. The path cost is added to the root path cost field in configuration messages received on the port to determine the total cost of the path to the root bridge. The default PATHCOST values depend on the port speed, according to the formula:

```
PATHCOST = 1000 / Port_Speed_in_MB_per_second
```

so that a port operating at 10Mbps has a default pathcost of 100, a port operating at 100 Mbps has a default pathcost of 10, and a port operating at 1 Gbps has a default pathcost of 1. Setting the pathcost to a larger value on a particular port is likely to reduce the traffic over the LAN connected to it. This may be appropriate if the LAN has lower bandwidth, or if there are reasons for limiting the traffic across it. To modify the STP port pathcost, use the command:

```
SET STP PORT={port-list|ALL} PATHCOST=1..1000000
```

If the PATHCOST of a port has not been explicitly set by the user, or the default values have been restored to the port, then the default PATHCOST for the port will vary as the speed of the port varies.

The default value for PATHCOST is set according to the speed. For a port operating at 100 Mbps, the default value is 19. For a port operating at 10 Mbps, the default value is 100.

To restore default port pathcost and priority, use the command:

```
SET STP PORT={port-list|ALL} DEFAULT
```

When an STP is enabled in a looped or meshed network, it disables and enables particular ports belonging to it dynamically, to eliminate redundant links. All ports in a VLAN belong to the same STP, and their participation in STP configuration, and hence the possibility of them being elected to the STP's active topology is enabled by default. To enable or disable particular ports, use the commands:

```
ENABLE STP PORT={port-list|ALL}
```

```
DISABLE STP PORT={port-list|ALL}
```

To display STP port information, use the command:

```
SHOW STP PORT[={port-list|ALL}]
```

Figure 15: Example output from the SHOW STP PORT command.

```
STP Port Information
------------------------------------------------------------
Port ..................... 1
  State .................. Forwarding
  STP ................... default
  STP Status ............ ON
  Port Priority ......... 128
  Port Identifier ....... 8001
  Pathcost .............. 19
  Designated Root ....... 32768 : 00-00-cd-00-45-c7
  Designated Cost ....... 0
  Designated Bridge ..... 32768 : 00-00-cd-00-a9-a5
  Designated Port ....... 8001
------------------------------------------------------------
```

Table 11: Parameters displayed in the output of the SHOW STP PORT command

Parameter	Meaning
Port	The number of the port.
State	The state of the port; one of "Disabled", "Blocking", "Listening", "Learning" or "Forwarding".
STP	The name of the STP that the port is a member of.
STP Status	The status of the STP that the port is a member of; one of "ON" or "OFF".
Port Priority	The priority of the port. Used as part of the Port Identifier field, it forms the upper 8 bits of the Port Identifier field.
Port Identifier	The unique identifier of the port. This parameter is used to determine the root port or designated port of the switch.
Pathcost	The path cost of the port.
Designated Root	The unique Bridge Identifier of the root bridge, as recorded in the configuration BPDU.
Designated Cost	The designated cost for the port.
Designated Bridge	Either the unique Bridge Identifier of the switch, or the unique Bridge Identifier of the switch believed to be the designated bridge for the LAN to which the port is attached.

Table 11: Parameters displayed in the output of the SHOW STP PORT command

Parameter	Meaning
Designated Port	The Port Identifier of the Designated Bridge through which the Designated Bridge transmits Configuration BPDU information stored by this port.

The spanning tree algorithm can be recalculated at any time, and all timers and counters be initialised, using the command:

```
RESET STP={stpname|ALL}
```

To show STP counters, use the command:

```
SHOW STP[={stpname|ALL}] COUNTER
```

Figure 16: Example output from the SHOW STP COUNTER command

```
STP Counters
-------------------------------------------------------------
STP Name: default
  Receive:                        Transmit:
  Total STP Packets          0     Total STP Packets           0
  Configuration BPDU         0     Configuration BPDU          0
  TCN BPDU                   0     TCN BPDU                    0
  Invalid BPDU               0

  Discarded:
  Port Disabled              0
  Invalid Protocol           0
  Invalid Type               0
  Invalid Message Age        0
  Config BPDU length         0
  TCN BPDU length            0
-------------------------------------------------------------
```

Table 12: Parameters in the output of the SHOW STP COUNTER command

Parameter	Meaning
STP Name	The name of the STP.
Receive	STP packets received.
Total STP Packets	The total number of STP packets received. Valid STP packets comprise Configuration BPDUs and Topology Change Notification (TCN) BPDUs.
Configuration BPDU	The number of valid Configuration BPDUs received.
TCN BPDU	The number of valid Topology Change Notification BPDUs received.
Invalid BPDU	The number of invalid STP packets received.
Transmit	STP packets transmitted.
Total STP packets	The total number of STP packets transmitted.
Configuration BPDU	The number of Configuration BPDUs transmitted.
TCN BPDU	The number of Topology Change Notification BPDUs transmitted.
Discarded	STP packets discarded.

Table 12: Parameters in the output of the SHOW STP COUNTER command

Parameter	Meaning
Port Disabled	The number of BPDUs discarded because the port that the BPDU was received on was disabled.
Invalid Protocol	The number of STP packets that had an invalid Protocol Identifier field or invalid Protocol Version Identifier field.
Invalid Type	The number of STP packets that had an invalid Type field.
Invalid Message Age	The number of STP packets that had an invalid message age.
Config BPDU length	The number of Configuration BPDUs that had an incorrect length.
TCN BPDU length	The number of Topology Change Notification BPDUs that had an incorrect length.

If necessary, all the STP configuration that users have created on the switch can be removed, so that all STPs except the default STP are destroyed, and all other defaults are restored, using the command:

```
PURGE STP
```

The PURGE STP command should be used with caution, and generally only before major reconfiguration of the switch, as it removes all STP configuration entered on the switch.

Interfaces to Layer 3 Protocols

Interfaces can be configured to VLANs for IP, IPX and Appletalk routing protocols in the same way that other interfaces are created for other interface types. Concatenate VLAN with the VID of the VLAN giving VLAN*n*, for instance:

```
INTERFACE=VLAN3
```

IGMP Snooping

IGMP (*Internet Group Management Protocol*) is used by IP hosts to report their multicast group memberships to routers and switches. IP hosts join a multicast group to receive broadcast messages directed to the multicast group address. IGMP is an IP-based protocol and uses IP addresses to identify both the multicast groups and the host members. For a VLAN-aware devices, this means multicast group membership is on a per-VLAN basis. If at least one port in the VLAN is a member of a multicast group, by default multicast packets will be flooded onto all ports in the VLAN.

IGMP snooping enables the switch to forward multicast traffic intelligently on the switch. The switch listens to IGMP membership reports, queries and leave messages to identify the switch ports that are members of multicast groups. Multicast traffic will only be forwarded to ports identified as members of the specific multicast group.

IGMP is used in conjunction with limited static multicast settings, or with DVMRP or PIM Sparse Mode for full multicast support (*IP Multicasting* chapter in the *Rapier Switch Software Reference*).

IGMP is enabled and disabled using the commands:

```
ENABLE IP IGMP

DISABLE IP IGMP
```

IGMP snooping is then enabled or disabled on a VLAN using the commands:

```
ENABLE IP IGMP INTERFACE={VLAN-vlanname|VLANvid}

DISABLE IP IGMP INTERFACE={VLAN-vlanname|VLANvid}
```

The switch will snoop IGMP packets transiting the VLAN and only forward multicast packets to the ports which have seen a membership report from network devices connected to those ports, instead of being forwarded to all ports belonging to the VLAN.

The command:

```
SET IP IGMP TIMEOUT=1..65535 QUERYINTERVAL=1..65535
```

sets operational parameters for IGMP. The QUERYINTERVAL parameter specifies the time interval, in seconds, at which IGMP Host Membership Queries are sent if this switch is elected the designated router for the LAN. The default is 125.

The TIMEOUT parameter specifies the longest interval, in seconds, that a group will remain in the local group database without receiving a Host Membership Report. The default is 270. If a value is specified for QUERYINTERVAL without specifying a value for TIMEOUT, TIMEOUT is calculated as 2*(QUERYINTERVAL + 10). The 10 seconds is the variation that hosts use when sending Host Membership Reports. If a timeout interval is specified, it will override any calculated value.

The command:

```
SHOW IP IGMP
```

displays information about IGMP, IGMP snooping, and multicast group membership for each VLAN-based IP interface (Figure 17 on page 57, Table 13 on page 58).

Figure 17: Example output from the SHOW IP IGMP command.

```
IGMP Protocol
-------------------------------------------------------------
Status ............................ Enabled
Default Query Interval ........... 125 secs
Default Timeout Interval ......... 270 secs
Interface Name ..........vlan2    (DR)
Group List ..............
  Group. 224.0.1.17 Last Adv. 192.168.1.130 Refresh time 27
  Group. 224.0.1.43 Last Adv. 192.168.1.130 Refresh time 27
  Group. 224.0.1.66 Last Adv. 192.168.1.140 Refresh time 27
```

Table 13: Parameters in the output of the SHOW IP IGMP command.

Parameter	Meaning
Status	The status of IGMP; one of "Enabled" or "Disabled".
Default Query Interval	The default interval at which Host Membership Queries are sent.
Default Timeout Interval	The default interval after which entries will be removed from the group database, if no Host Membership Report is received.
Group List	A list of multicast group memberships for this interface.
Group	The group multicast address.
Last Adv.	The last host to advertise the membership report.
Refresh time	The time interval (in seconds) until the membership group will be deleted if it does not receive another membership report before then.

Triggers

The Trigger Facility can be used to automatically run specified command scripts when particular triggers are activated. When a trigger is activated by an event, global parameters and parameters specific to the event are passed to the script that is run. For a full description of the Trigger Facility, see the *Trigger Facility* chapter in the *Rapier Switch Software Reference*.

The switch can generate triggers to activate scripts when a fibre uplink port loses or gains coherent light. To create or modify a switch trigger, use the commands:

```
CREATE TRIGGER=trigger-id MODULE=SWITCH
   EVENT={LIGHTOFF|LIGHTON} PORT=port [AFTER=hh:mm]
   [BEFORE=hh:mm] [DATE=date|DAYS=day-list] [NAME=name]
   [REPEAT={YES|NO|ONCE|FOREVER|count}] [SCRIPT=filename...]
   [STATE={ENABLED|DISABLED}] [TEST={YES|NO|ON|OFF}]

SET TRIGGER=trigger-id PORTS={port-list|ALL} [AFTER=hh:mm]
   [BEFORE=hh:mm] [DATE=date|DAYS=day-list] [NAME=name]
   [REPEAT={YES|NO|ONCE|FOREVER|count}]
   [TEST={YES|NO|ON|OFF}]
```

The following sections list the events that may be specified for the EVENT parameter, the parameters that may be specified as *module-specific-parameters*, and the arguments passed to the script activated by the trigger.

Event LINKDOWN

Description The port link specified by the PORT parameter has just gone down.

Parameters The following command parameter(s) must be specified in the CREATE/SET TRIGGER commands:

Parameter	Description
PORT=*port*	The port on which the event will activate the trigger.

Script Parameters The trigger passes the following parameter(s) to the script:

Argument	Description
%1	The port number of the port which has just gone down.

Event LINKUP

Description The port link specified by the PORT parameter has just come up.

Parameters The following command parameter(s) must be specified in the CREATE/SET TRIGGER commands:

Parameter	Description
PORT=*port*	The port on which the event will activate the trigger.

Script Parameters The trigger passes the following parameter(s) to the script:

Argument	Description
%1	The port number of the port which has just come up.

Chapter 5

Layer 3 Switching

The Rapier switch provides Layer 3 switching and routing over VLANs. Once a VLAN has been created (see "Virtual LANs" on page 35), the VLAN name can be used wherever a logical interface is required in commands for configuring routing protocols.

VLAN names are of the form:

```
VLAN-vlanname
```

or

```
VLANn
```

where *vlanname* is the manager-assigned name of the VLAN, and *n* is the VLAN identifier (VID).

For example, if a VLAN is created using the command:

```
CREATE VLAN=admin VID=11
```

then the following names can be used to identify the VLAN in routing commands:

```
vlan-admin
```

```
vlan11
```

The following sections illustrate the use of VLANs for IP, RIP, IPX, AppleTalk and RSVP. For a complete description of all the protocols supported by the switch, see the *Rapier Switch Software Reference*.

Internet Protocol (IP)

The switch performs IP routing at wire speed between VLANs. To add the admin VLAN as an IP interface, use either of the following commands:

```
ADD IP INTERFACE=vlan-admin
```

```
ADD IP INTERFACE=vlan11
```

The command:

```
SHOW IP INTERFACE
```

displays the interfaces enabled for IP routing (Figure 18 on page 62).

Figure 18: Example output from the SHOW IP INTERFACE command.

```
Interface     Type     IP Address       Bc Fr PArp  Filt RIP Met.   SAMode  IPSc
Pri. Filt     Pol.Filt Network Mask     MTU   VJC   GRE  OSPF Met.  DBcast  Mul.
-------------------------------------------------------------------------------
LOCAL         -        Not Set          -  n  -     ---  -          -       --
---           ----     -                -     -     ---  -          -       ---
vlan11        Static   192.168.163.39   1  y  On    ---  01         Pass    --
---           ---      255.255.255.0    1500  -     ---  0000000001 No      On
ppp1          Dynamic  0.0.0.0          1  y  -     ---  01         Pass    --
---           ---      255.255.255.255  1500  Off   ---  0000000001 No      On
-------------------------------------------------------------------------------
```

IP Multicasting

Static multicast forwarding can be configured using the ADD IP INTERFACE or SET IP INTERFACE commands. Full multicast functionality requires IGMP and DVMRP or PIM-Sparse Mode.

The advanced feature licence AT-RPFL3Upgrade is required for IGMP, DVMRP and PIM Sparse Mode.

The switch supports IP multicast routing protocols DVMRP (Distance Vector Multicast Routing Protocol) and PIM Sparse Mode (Protocol Independent Multicast – Sparse Mode. Management of group members is performed using IGMP (Internet Group Management Protocol). IGMP snooping reduces unnecessary multicast traffic between members of the same VLAN. See the *IP Multicasting* chapter in the *Rapier Switch Software Reference*.

Routing Information Protocol (RIP)

Routing protocols such as RIPv1 and RIPv2 can be enabled on a VLAN. For example, the command:

```
ADD IP RIP INTERFACE=vlan11 SEND=RIP2 RECEIVE=BOTH
```

enables RIPv2 on the admin VLAN. The command:

```
SHOW IP RIP
```

displays information about RIP (Figure 19 on page 62).

Figure 19: Example output from the SHOW IP RIP command.

```
Interface  Circuit/DLCI    IP Address     Send  Receive  Demand  Auth  Password
-------------------------------------------------------------------------------
vlan11     -               -              RIP2  BOTH     NO      NO
ppp0       -               172.16.249.34  RIP1  RIP2     YES     PASS  ********
-------------------------------------------------------------------------------
```

Novell IPX

The advanced feature licence AT-RPFL3Upgrade is required for this feature.

The switch's implementation of the Novell IPX protocol uses the term *circuit* to refer to a logical connection over an *interface*, similar to an X.25 permanent virtual circuit (PVC) or a Frame Relay Data Link Connection (DLC). The term *interface* is used to refer to the underlying physical interface, such as VLAN, Ethernet, Point-to-Point (PPP) and Frame Relay.

To create IPX circuit 1 with the Novell network number 129 over the admin VLAN, use the command:

```
ADD IPX CIRC=1 INTERFACE=vlan11 NETWORK=129 ENCAP=802.3
```

The command:

```
SHOW IPX CIRCUIT
```

displays information about the circuits configured for IPX (Figure 20).

Figure 20: Example output from the SHOW IPX CIRCUIT command.

```
IPX CIRCUIT information

Name ......................... Circuit 1
Status ....................... enabled
Interface .................... vlan11   (802.3)
Network number ............... c0e7230f
Station number ............... 0000cd000d26
Link state ................... up
Cost in Novell ticks ......... 1
Type20 packets allowed ....... no
On demand .................... no

Spoofing information
Keep alive spoofing .......... no
SPX watch dog spoofing ....... no
On SPX connection failure .... UPLINK
On end of SPX spoofing ....... UPLINK

RIP broadcast information
Change broadcasts ............ yes
General broadcasts ........... yes
General broadcast interval ... 60 seconds
Maximum age .................. 180 seconds

SAP broadcast information
Change broadcasts ............ yes
General broadcasts ........... yes
General broadcast interval ... 60 seconds
Maximum age .................. 180 seconds

Filter information
Filters ...................... none
```

AppleTalk

The advanced feature licence AT-RPFL3Upgrade is required for this feature.

To create an AppleTalk port (interface) associated with the admin VLAN, use the command:

```
ADD APPLE PORT INTERFACE=vlan11
```

The command:

```
SHOW APPLE PORT
```

displays information about the ports configured for AppleTalk (Figure 21 on page 64).

Figure 21: Example output from the SHOW APPLE PORT command.

```
Appletalk Port Details
-----------------------------------
  Port Number ............... 1
  Interface ................. vlan11
  ifIndex ................... 1
  Node ID ................... 217
  Network Number ............ 22
  Network Range Start ....... 22
  Network Range End ......... 22
  State ..................... ACTIVE
  Seed ...................... NO
  Seed Network Start ........ 0
  Seed Network End .......... 0
  Hint ...................... YES
  Hint Node ID .............. 179
  Hint Network .............. 22
  Default Zone .............. -

  Zone List is Empty
-----------------------------------
```

Resource Reservation Protocol (RSVP)

The advanced feature licence AT-RPFL3Upgrade is required for this feature.

The Resource Reservation Protocol (RSVP) enables the receiver of a traffic flow to make the resource reservations necessary to ensure that the receiver obtains the desired QoS for the traffic flow.

RSVP is disabled by default. To enable RSVP, use the command:

```
ENABLE RSVP
```

Each IP interface that is to receive and process RSVP messages and accept reservation requests must be enabled. To enable RSVP on the admin VLAN, use the command:

```
ENABLE RSVP INTERFACE=vlan11
```

The command:

```
SHOW RSVP INTERFACE
```

displays information about the interfaces enabled for RSVP (Figure 22).

Figure 22: Example output from the SHOW RSVP INTERFACE command.

```
RSVP Interfaces
                    Maximum       Reserved       No. Of
Interface  Enabled  Bandwidth(%)  Bandwidth(%)   Reservations  Debug     Encap
-------------------------------------------------------------------------------
Dynamic      No        75             0              0         None      RAW
vlan11       Yes       75             0              1         None      RAW
ppp0         Yes       75             0              0         None      RAW
-------------------------------------------------------------------------------
```